

Research Article

Risk Management of New Cosmetic Product Development Based on Data Management of Visualization in Scientific Computing

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With the continuous development of the social economy, people pay more and more attention to their own protection and maintenance, especially the quality of commodities in terms of usage of the commodity. As commonly used commodities, the quality of their new products in cosmetics is extremely important. In the rapidly developing cosmetics industry, in view of these needs and limitations, the data management method of visualization in scientific computing is introduced in this paper. Multiple risk factors in cosmetics development are established and sorted from the three perspectives of cosmetics development, production, and sales, by combining the new cosmetic product development process. The biggest risks are clarified, the corresponding cosmetic product risk assessment model is constructed, and the new cosmetic product development risk strategy and related management are realized. The simulation experiment results show that the data management method of visualization in scientific computing is effective and can support the risk management of new cosmetic product development.

1. Introduction

With the continuous development of the social economy, the living standards of residents have been continuously improved, and the exchange of information has gradually become smoother [1, 2]. For the cosmetics industry, the scale of the domestic market is gradually increasing and ascending year by year, and China has gradually become a larger consumer market for cosmetics [3, 4]. Regarding the use of cosmetics, the market is also increasing both domestically and abroad. The product competition is gradually becoming fierce among cosmetics companies [5, 6]. In order to ensure the quality and supervision of cosmetics, China has successively promulgated relevant laws and regulations on cosmetics, which have become important measurement standards [7, 8]. On the other hand, as far as the cosmetics market is concerned, the cosmetics industry is booming, creating a large number of jobs and also bringing great tax revenue to the country, and it has also been favored by related capital [9, 10].

Information transmission technology and mobile terminal technology have spawned many cosmetics markets. The processes change with each passing day from raw material production, ingredient synthesis, medical engineering, and other processes, but they have brought about safety issues in a cosmetic product, and consumers have suffered a lot of harm [11, 12]. From the perspective of beauty cosmetics of more minorities, the rapid emergence is realized. For actual cosmetics sales personnel, they tend to neglect quality management and attention to laws and regulations is lacking. It will cause safety problems to cosmetics, which will have a great impact on enterprises and consumers [13, 14]. For cosmetics, cosmetics are processed according to different raw materials according to fixed formula ratios, and according to different production methods [15]. No matter how many factors affect the quality of products, the raw materials of cosmetics have gradually become the quality control gates that affect cosmetic products [16, 17]. According to the corresponding cosmetic production process standards, the control of product-related risk factors in multiple links and multiple

industrial chains is realized from the initial selection of raw materials, product processing, and product final packaging. For cosmetic products, its safety lies mainly in the cosmetics manufacturer. Therefore, for cosmetic products, risk management is the key point of product safety, which is important factor to ensure product quality and ensure the core competitiveness of enterprises [18, 19]. In response to these needs and actual influencing factors, the industrial chain of cosmetics development, production, packaging, sales, etc. is sorted out in this paper, based on the method of visualization in scientific computing, to clarify the influencing factors of cosmetics, construct corresponding influence models, and the safety factors of cosmetics are analyzed, aiming at realizing the risk strategy and related management of the development of new cosmetic products.

2. Product Safety and Risk Management at the R&D Stage

From the perspective of cosmetic products, the realization of cosmetic product development is mainly analyzed from three aspects, the selection of cosmetic raw materials, the configuration and evaluation of formulas, and risk assessment.

2.1. Selection of Raw Material. Cosmetics is a synthetic chemical product that is synthesized from multiple raw materials, such as specific chemical products, pesticide residues, and other harmful substances that may gradually enter the cosmetics based on the corresponding raw materials.

For malicious increases or artificial increases, many safety incidents may be caused by different raw materials of cosmetic products or different screenings. Therefore, how to carry out difference, prevention, and control of raw materials is the risk management of cosmetics safety [20–25].

For the entire screening of cosmetic raw materials, how to ensure that there is quality control and safety assessment in the entire process is extremely important. Therefore, a strict screening mechanism needs to be followed, and the raw material of each cosmetic needs to have a complete source, proportion, storage environment, and other related data storage, especially for human skin related testing, such as eye testing, skin testing, allergy testing, etc.

2.2. Screening and Evaluation of Formula. In the second step, the formula screening step of cosmetics, it is necessary to clarify that cosmetics are different from ordinary drugs. Drugs are an important synthetic product manufactured to deal with illness, but once the corresponding illness disappears, medicine does not need to be reused; but cosmetics are different. They are common items in daily life, so they should not and cannot have any possible risks. Therefore, safety is the first consideration. Other storage, functionality, and stability need to be developed for new cosmetic products based on safety. If necessary, if sufficient safety cannot be ensured, the development of a new product can even be canceled.

For the safety test of cosmetics, to some extent, continuous testing is first required. The tested subject needs to meet relevant regulations and needs, and age groups should also be differentiated. Quantitative assessments should be carried out through different indicators to determine whether there are any hidden dangers of safety and irritation in the new products?

When the net content of the test is less than 25 g, the number of test experiments needs to be increased. In order to further facilitate retrieval, the detailed test content is shown in Tables 1 and 2.

2.3. Risk Assessment of Safety Risk Substances. Effective assessment of safety risk substances is conducted at different stages, and whether the new cosmetic products have certain risks and whether the safety meets the actual needs of users are determined according to the actual use of users. Effective safety assessment during the product development stage is conducted to facilitate manufacturers and research institutions to fully understand whether cosmetic products are dangerous so as to clarify whether the product or certain ingredients may be risky.

Hazard identification: By analyzing various ingredients of cosmetics, especially the ingredients in the hazard database, it shall be distinguished and clarified how these ingredients are produced and identified and used, who the audience of the product is, and whether it will have a certain impact, and whether these people are allergic to these ingredients, etc. For these situations, a database of new cosmetic products needs to be established, and corresponding safety factors and adverse reaction prompts are established for each person's different situations.

Quantitative measurement of exposure: clarify the audience of new cosmetic products, comprehensively consider the practice and frequency of exposure in the usage of new cosmetic products in multiple situations and multiple scenarios, and whether there are extreme exposures and actual exposures for different exposures for specific assessment and estimation of human use and absorption.

Dose-response relationship assessment: Carry out corresponding tests according to the safety level of different cosmetics to determine the specific threshold level. Meanwhile, construct a comprehensive curve of the corresponding dose and the actual response to realize the reversibility test of the response.

Quantitative measurement and characterization of risks: the human body's concerns are analyzed and tested with different cosmetic exposures, and safety data is analyzed through different trade-offs to observe other adverse reactions and clarify specific exposure boundaries. The boundaries exposed are analyzed in quantification, and factors that are not sufficiently certain in safety data are analyzed to determine whether they can cover more people or support users to use cosmetics with a larger exposure boundary.

Risk management: reduce the risk of imitation of new cosmetic products through identification, QR code traceability, and tracking, and form a complete responsibility traceability mechanism.

TABLE 1: Special-purpose cosmetics testing items, testing period, and sample quantity.

Project name	Hair growth	Bodybuilding/ beautiful breast	Hair dye	Perm	Sunscreen	Deodorant	Freckle	Hair removal
Microorganism	O	O			O		O	
Lead, mercury, arsenic	O	O	O	O	O	O	O	O
Methanol						O		
Formaldehyde								O
Thioglycolic acid				O				
Phenol, hydroquinone							O	
Sex hormone	O	O						
Sun-screening agent					O			
Dyes in oxidative hair dyes			O					
Chlormethine, mylabris radix asparag	O							
PH value				O			O	O
Acute eye irritation test	O		O	O				
Acute skin irritation test				O				
Multiple skin irritation tests	O	O			O	O	O	
Skin allergy reaction test	O	O	O	O	O	O	O	O
Skin phototoxicity test	O				O		O	
Salmonella typhimurium/reverse mutation test	O	O	O					
In vitro mammalian cell chromosome aberration test	O	O	O					
Detection cycle	90 days	90 days	90 days	50 days	90 days	90 days	90 days	90 days
Number of samples	20	15	15	15	25	16	20	15

TABLE 2: Nonspecial use cosmetics testing items, testing period, and sample quantity.

Project name	Hair use class	Skin care		Makeup			Finger nail (toe)	Aromatic
	Eye-friendly hair products	General skin care products	Eye-friendly skin care products	General cosmetics	Eye makeup products	Lip care and lip makeup products		
Lead, mercury, arsenic	O	O	O	O	O		O	O
Methanol								O
a-hydroxy acid, pH								
Antibiotics, metronidazole anti-dandruff agent asbestos								
Acute skin irritation test	O						O	O
Eye irritation test	O		O		O			
Multiple skin irritation tests		O	O	O	O			
Detection cycle	30 days	65 days	65 days	56 days	56 days	25 days	25 days	30 days
Number of samples	11	11	15	14	12	13	14	10

For the assessment of safety risk substances, the specific assessment process diagram is shown in Figure 1.

The corresponding safety test certificates and other specific safety requirements need to be provided for the new cosmetic products. The specific process requirements are shown in Figure 2.

3. Product Safety and Risk Management at the Production Stage

During the safety production and management stage of cosmetics, several key nodes need to be focused adequately on: the selection and storage of raw materials, the

quantitative configuration of raw materials, the production and packaging of products, and the inspection, storage, and distribution of products.

During the production stage of new cosmetic products, the key safety management, and risk control mainly lie in personnel control, system control, raw material supplier control, and cosmetic production management.

Various necessary trainings are required for different production personnel. Both new employees and existing old employees must keep safety first-in mind at all times. The content of the training may involve on-the-job operations, quality requirements, common sense of hygiene management, and knowledge of safe production. Training methods

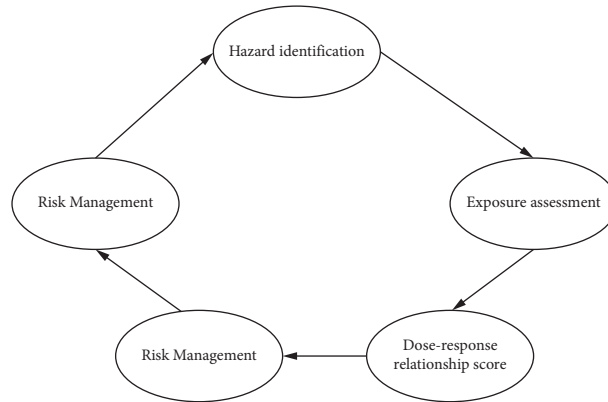


FIGURE 1: Risk assessment process of safety risk substances.

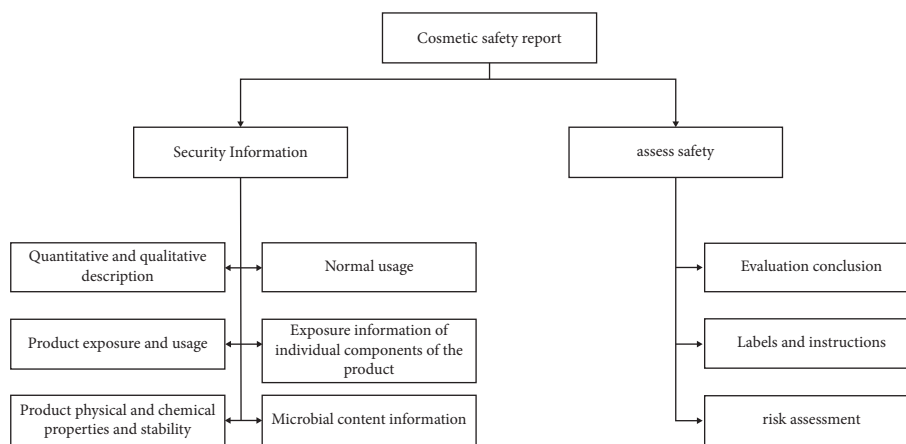


FIGURE 2: Cosmetic safety report.

can be conducted through online lectures, on-the-job lectures, internal off-job training, expert lectures, and third-party professional organization training. Different training methods can be selected according to different training contents and different training requirements. In the end, it can also be comprehensively assessed through specific operations, cultural examinations, and interviews. When necessary, the corresponding authentication can also be carried out by means of a third-party certificate.

The management of suppliers can be achieved at the beginning of the raw material screening. The preliminary screening is carried out by setting the corresponding qualifications and scales, and the corresponding supply capacity and raw material sources are quantitatively evaluated. For some suppliers that do not meet the needs, they shall be removed from the ranks of suppliers, and the remaining suppliers still need to conduct quality and risk assessments. If conditions permit, due diligence shall be conducted as far as possible and meanwhile, necessary supplier records shall be made, and reasonable notification and knowledge of major events in the supply process shall be conducted for unceasing retrospect.

A certain level of classification shall be carried out for suppliers and manufacturers of cosmetic raw materials, and

the necessary annual audits shall be carried out in accordance with the order of priority.

3.1. Raw Materials Warehousing. The initial step of cosmetic production is the warehousing inspection of the raw materials of new cosmetic products. The inspection needs to be conducted in an environment of a professional laboratory. Secondly, reasonable laboratory tests should be carried out through specific indicators such as acidity and alkalinity and ingredient content. Meanwhile, when necessary, corresponding microbiological testing should also be added, and effective measurement and analysis of risky substances should be done for certain impurities in the raw materials.

Due to differences in raw materials and productions, it is necessary to adopt different cosmetic storage methods according to different cosmetics production raw materials. Make sure that the cosmetics need to be retested within the shelf life, especially for the formulation, appearance, pH, and iodine value of the raw materials. Other key indicators must comply with relevant national standards and requirements, be recorded accordingly, and achieve evidence-based record keeping.

3.2. Quantitative Allocation of Raw Materials. In the stages of raw material weighing and paste preparation, a strict preparation process should be followed.

3.3. Packaging Inspection of Product. The production of new cosmetic products requires inspection and check at the production and canning stages, which mainly include inspection of semifinished products and inspection of new canned products. The packaging inspection also needs to be carried out in strict accordance with the actual product packaging, and meanwhile, analysis and measurement are carried out from multiple factors such as pH, density, viscosity, odor, preservatives, etc.; meanwhile, packaging and inspection of cans need to be carried out in strict accordance with the operating instructions, such as printing, coding, anticounterfeiting labels, etc.; the finished product needs to be tested again for the total number of colonies, the total number of molds and yeasts, pathogens, and the comparison of standard sample to ensure that the paste is correct, there is no foreign matter in the paste, and the clarification of the transparent product, foreign matter, impurities, black spots, etc.

3.4. Warehousing and Distribution. In the storage process of new cosmetic products, different storage conditions need to be adopted according to different products. For instance, some new products need to be stored at low temperature, which requires the temperature of the entire storage to be within a certain threshold range while controlling humidity to achieve effective first-in, first-out. For companies with capabilities and needs, they can also use informatization and electronic equipment for effective differentiation and real-time control of quality status.

During the transportation of new cosmetic products, it is necessary to adopt suitably enclosed compartments to provide effective protection for the new cosmetic products. It is necessary to carry out corresponding sanitary inspections for the transported vehicles, and the vehicles that do not meet the sanitary conditions do not need to be arranged for transportation to realize the effective tracking and transportation of the telephone and carry out timely processing.

A complete quality system should establish regulations, material control, facilities and equipment, process and production control, packaging and labeling, and laboratory control. All departments should join forces.

4. Parallel Processing of Scientific Computing

For new cosmetic products, a large amount of data appears in the process of development, storage, and transportation, and different cosmetic products also bring different data. Therefore, the processing of these data requires scientific computing for parallel processing. How to use the corresponding parallel processing tools is extremely important.

In this paper, the Silo tool is selected for the effective processing of visualization in scientific computing. It has two important features. In the same file, different

workspaces can be created as needed; for the same multi-block object, multiple Silo file can be integrated effectively. Therefore, for parallel processing applications, it is relatively easy to divide the required processors into N different combinations and is written into a single file with a silo. The specific parallel processing principle is shown in Figure 3.

The safety and risk management of cosmetics sales can be divided into two important key nodes: after-sales problems and the detection and statistics of adverse reactions to cosmetics. Once the cosmetics are sold, they enter a new stage, which is the after-sales stage. Users need to make complaints and feedback through online mailboxes, telephones, etc., and they can also obtain other customers' comments on cosmetics through social platforms such as Weibo, to achieve long-term monitoring and evaluation of adverse reactions to cosmetic products.

The occurrence of adverse reactions to different cosmetics can be investigated and traced, and monitoring can be realized from multiple aspects: when raw materials are screened for warehousing, the corresponding batches, quantities, production dates, and suppliers can be traced; through the use of raw materials, it can realize the analysis of the usage quantity and internal transfer; whether there is a lot number and sorting for the new cosmetic products in the warehouse; for after-sales information, the after-sales information can be used for sorting, customer information tracking, etc. Through the evaluation of after-sales service complaints and feedback information, we can judge the importance and significance of the feedback information, select specific opinions to achieve specific later improvements, and handle complaints in a timely manner.

For new cosmetic products, there are certain production risks in each production process. How to effectively reduce the unit production cost and efficiency in each link, that is, to achieve orderly risk control through limited resources, in order to achieve the purpose of risk reduction, the continuous optimization of decision-making is realized, and the corresponding mathematical model is established to weigh the contradictions and realize the optimization of the plan.

Generally, the purpose of risk control, the comprehensive risk reduction rate of new product development, is a fuzzy quantity. Therefore, in order to plan the optimal risk control plan, fuzzy theory is introduced and a fuzzy linear programming model (FLP) is established. The goal of model planning is to minimize the total cost of risk control. The constraint condition is that the comprehensive risk reduction rate of new product development is approximately greater than or equal to the risk reduction management goal. The decision variable of the model is the reduction rate of risk occurrence probability.

The specific production risk control model for new product development is shown in the following formulas:

$$\min C = \sum_{i=1}^m C_i \Delta p_i, \quad (1)$$

$$\text{s.t. } \sum_{i=1}^m e_i \Delta P_i \geq R, \quad (2)$$

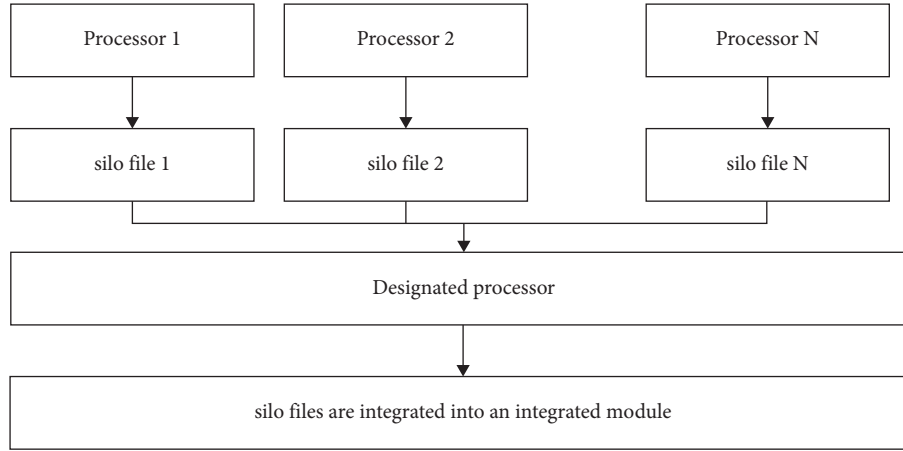


FIGURE 3: Parallel principle of silo.

$$0 \leq \Delta p_i \leq 1, \quad (i = 1, \dots, m). \quad (3)$$

Among them, the total cost of risk control is denoted by C , the new product development risk reduction target is denoted by R , the weight of risk factors is denoted by p_i , the probability of risk occurrence is denoted by c_i , and the unit cost of risk occurrence is denoted by r_i .

The reduction rate that defines the probability of occurrence of risk can be expressed by the following formula:

$$\Delta P_i = \frac{P_i - P'_i}{P_i - P_i^*}. \quad (4)$$

Among them, the current occurrence probability of the risk factor is denoted by L_1, L_2, \dots, L_m ; the probability of occurrence of the i -th risk factor after risk control is denoted by p'_i ; the lowest value of the reduction in the occurrence probability of the i -th risk factor is denoted by p_i^* .

Let $t = \sum_{i=1}^m e_i \Delta p_i$, the fuzzy constraint $t \geq R$ is expressed in the form of membership function as shown in the following formula:

$$\underline{A}(t) = \begin{cases} 0, & t < R - d, \\ 1 + \frac{(t - R)}{d}, & R - d \leq t < R, \\ 1, & t \geq R. \end{cases} \quad (5)$$

In the formula, A represents the paste subset, d represents the scaling index of the risk equivalent reduction rate, and $d \geq 0$.

The corresponding fuzzy target set \underline{G} can be defined as shown in the following formula:

$$\underline{G}(t_0) = \begin{cases} 1, & t_0 \leq C_0 - d_0, \\ \frac{(C_0 - t_0)}{d_0}, & C_0 - d_0 < t_0 \leq C_0, \\ 0, & t_0 > C_0. \end{cases} \quad (6)$$

The principle of maximum membership is used to find the optimal solution of the fuzzy linear programming model, and the linear programming model 2 (LP2) for the optimal solution of FLP is established as shown in the following formula:

$$\begin{aligned} & \max \lambda \\ & \text{s.t.} \quad \sum_{i=1}^m c_i \Delta p_i + d_0 \lambda \leq C_0, \\ & \quad \sum_{i=1}^m e_i \Delta p_i - d \lambda \geq R - d, \\ & \quad 0 \leq \Delta p_i \leq 1 \quad (i = 1, \dots, m), \quad \lambda \geq 0, \end{aligned} \quad (7)$$

where λ is threshold or confidence level.

5. Simulation and Identification of Risks in the Development of New Cosmetic Products

Risk refers to the possibility of loss and its influence. The value of risk is proportional to its variables. The greater the probability or influence, the higher the risk.

The so-called risk management refers to the process of identifying and measuring risks and taking effective measures to deal with these risks. The new product development risk management of cosmetics generally includes several steps: risk identification, risk assessment, and risk countermeasures.

5.1. Sources of Risks in the Development of New Cosmetic Products. The first step in risk identification is to determine which areas the risk comes from. The risk of failure in the development of new cosmetic products mainly comes from three areas: market, technology, and finance.

5.2. The Risk Indicator System for the Development of New Cosmetic Products. After determining the risk areas, the specific risk factors that affect the development of new products in each risk area need to be found to establish a risk index system and complete the purpose of risk identification.

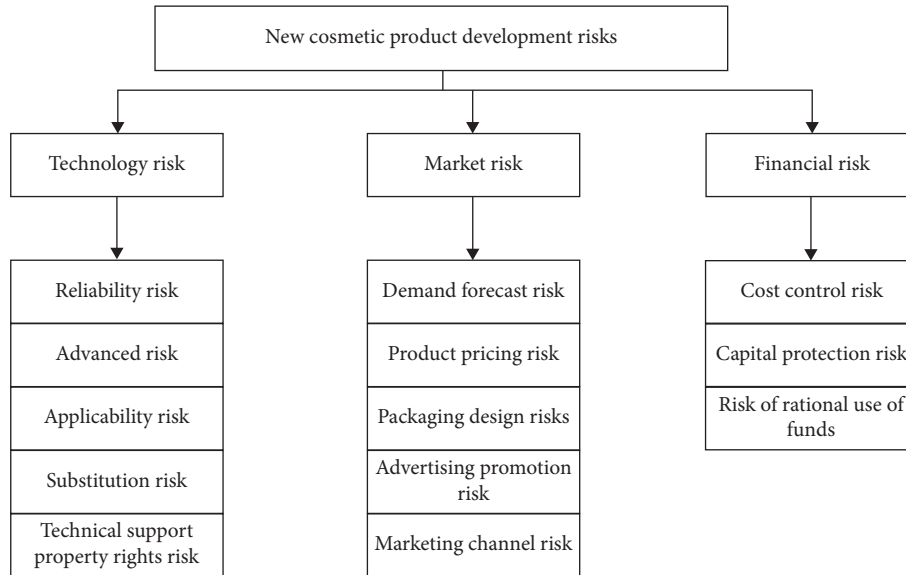


FIGURE 4: The risk indicator system for the development of new cosmetic products.

TABLE 3: Comprehensive risk evaluation table.

Risk risk values process	L1	L2	.....	Ln	Various risk values
R1	r11	r12	.....	r1n	$r1 = r11 + r12 + \dots + r1n$
R2	r21	r22	.....	r2n	$r2 = r21 + r22 + \dots + r2n$
.....
Rm	rm1	rm2	.....	rmn	$rm = rm1 + rm2 + \dots + rmn$
Total risk score					r

The risk indicator system for the development of new cosmetic products (as shown in Figure 4).

5.3. Risk Assessment Model Based on Subjective Scoring Method.

- (1) Determine the individual risk value. Assuming that the probability of occurrence of a certain risk factor R_i is p_i in a certain development process, the degree of impact after it occurs is c_i , and the risk value is r_i , and each risk value is determined according to the formula risk value = probability * degree of influence.
- (2) Evaluate the overall risk level. Assuming that a product development activity has m risk factors and must go through n development processes, its comprehensive risk score is shown in Table 3.
- (3) Evaluate the risk level of the main risk areas. Through the above table, we can also get the ranking of various risk factors according to the risk value so as to find the main risk areas. And use the same method to calculate the risk level of the main risk areas.

5.4. Assessment of Risks in the Development of New Cosmetic Products. A cosmetics company intends to develop a new product. The experts obtained the following risk evaluation

form after analyzing the company’s internal and external environment (Table 4).

According to the risk value of each risk factor, the risks of the new product development activity can be ranked. Part of the results is shown in Figure 5.

In terms of the results, the main risk area for the development of new cosmetic products comes from the market, and the level of market risk can be calculated to be 0.59.

6. Risk Countermeasures for the Development of New Cosmetic Products

Risk response refers to the reasonable risk disposal opinions and methods are proposed through identification, evaluation, and estimation of risks, after considering the comprehensive factors of risk. There are four types of risk response strategies: risk reserve, risk mitigation, risk transfer, and risk avoidance.

Different risk response strategies are applied to different risk levels. The two dimensions of risk evaluation, namely the overall risk level and the risk level of the main risk areas are compared with the risk level benchmark, and a reasonable response strategy is obtained, as shown in Figure 6.

According to Figure 6, for the development of new cosmetic products, risk mitigation and risk transfer should be adopted to reduce risks.

TABLE 4: Risk evaluation form of a cosmetics company.

Risk risk values development process	R&D	Design	Trial production	Production	Sales	Various risk values
Technical reliability risk R11			2*3	2*5		16
Technological advancement risk R12			3*2	3*3		15
Technology applicability risk R13			3*3	3*4		21
Technology substitutability risk R14			2*2	2*3		10
Technology intellectual property risk R15	2*4	2*4				16
Demand forecast risk R21	4*5	3*4		3*4	5*5	69
Product pricing risk R22					4*4	16
Packaging design risk R23		3*5			3*4	27
Advertising promotion risk R24					4*4	16
Marketing channel risk R25					4*4	16
Product life cycle risk R26				3*3	3*3	18
Cost control risk R31	2*3	1*3	1*2	3*3	1*2	22
Capital guarantee risk R32	1*2	1*1	1*2	2*3	1*2	13
Risk of rational use of funds R33	2*1	1*2	1*1	2*3	1*2	13
Total risk	38	41	30	79	100	288

The overall risk level of the new product development activity can be obtained as $t = r/rs = 296/900 = 0.328$.

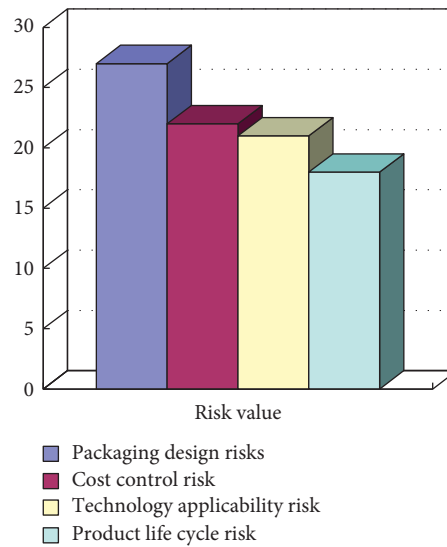


FIGURE 5: Ranking of risk factors of a certain cosmetics company.

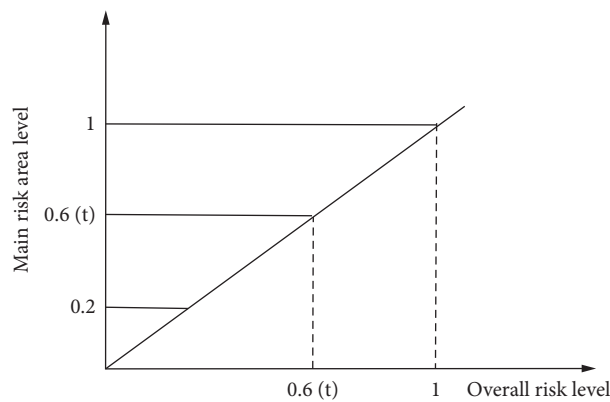


FIGURE 6: Risk response strategy diagram for the development of new cosmetic products.

7. Conclusions

As an important daily necessity, the safety of cosmetics is extremely important. How to ensure the safety of cosmetics production requires proper preparation and risk supervision from the early stage of testing. Cosmetic manufacturers must be prepared to deal with the technical capabilities of cosmetics testing, establish a sound quality risk management system of raw material, and ensure the safety of cosmetics from the source. Based on the data management method of visualization in scientific computing, possible risk factors are analyzed by combing the development, production, sales, and other chains of new cosmetic products, and these risks are quantitatively analyzed and evaluated to build a corresponding risk assessment model, realize effective supervision and traceability of new cosmetic products, and realize the risk strategy and related management of new cosmetic product development. The simulation experiment results show that the data management method of visualization in scientific computing is effective and can support the risk management of the development of new cosmetic products. Reasonable management and control of the quality risks of cosmetic raw materials can enable the cosmetics industry to achieve sustainable development on a healthy track.

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 no conflicts of interest.

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