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Abstract

Based on the analysis of the risk occurrence path of prefabricated buildings, this paper identifies the key factors of construction risk, expounds the risk occurrence mechanism of construction, and builds a risk assessment model of construction based on Monte Carlo visual recognition neural network. At present, with the rapid development of social economy, various materials have been excavated and put into use in the field of construction. In addition to contemporary problems with materials pollution have become increasingly prominent, especially in the construction industry. People have begun to pursue a more comfortable and environmentally friendly housing environment. Prefabricated buildings have their unique advantages in the modernization of such a construction industry developed against the background. Due to the change in the construction mode, the quality of design and construction personnel, as well as the existing technical capabilities and supporting facilities have not reached the due level, and the resulting safety problems need to be solved urgently. There are many risk factors in the implementation process, and the risks The probability and consequences are difficult to accurately judge. In this paper, through the identification of risks in prefabricated building projects, a risk index evaluation system is established, and the risk of prefabricated buildings is evaluated and studied risk evaluation, the influence of human subjectivity can be overcome, and the evaluation results can be It is more accurate and reasonable, and finally achieves the purpose of risk management and control, and puts forward corresponding measures according to the evaluation results, which provides new ideas and methods for the risk assessment and model optimization research of prefabricated buildings.

Key words

Monte Carlo; neural network; prefabricated building; risk assessment; Simulation of computational neural models for visual recognition

Introduction

Based on the analysis of the risk occurrence path of prefabricated buildings, this paper identifies the key factors of construction risk, expounds the risk occurrence mechanism of construction, and builds a risk assessment model of construction based on Monte Carlo visual recognition neural network. The construction industry urbanization in my country, but at the same time it also exposes a series of drawbacks [1]. The cast-in-place operation used in the traditional construction industry has many hidden safety hazards, and the problem of environmental pollution is becoming more and more prominent. According to statistics, in 2016, accounted for 20.6% of the national energy consumption, and the total amount of building 19.4% [2]. People's calls for ecological protection and resource conservation are becoming stronger and stronger. At the same time, higher requirements are placed on the
Prefabricated buildings are the most typical building models in the development of building industrialization. They are developing rapidly all over the world with the advantages of high quality, low pollution, short construction period and high degree of industrialization [4]. Although my country's prefabricated building was proposed earlier, it is still in its infancy compared to one. In recent years, the extensive production of my country's construction industry has caused extremely serious waste of materials and sharply increased environmental pollution. [5].

Such environmental protection, greenness, reduction of labor costs, improvement of labor productivity and project quality, etc., which are in line with my country's sustainable development concept and the principle of "four sections and one environmental protection". Prefabricated buildings have well adapted to the needs of my country's economic transformation from "extensive" to "intensive", and catered to the requirements of construction industrialization [6]. In view of this, a large number of prefabricated construction projects are widely emerging buildings. While scale of prefabricated construction projects continues to expand, construction projects are becoming more and more difficult. It is necessary to build a risk assessment construction projects [7].

Prefabricated buildings started late in my country, and the theoretical system of risk assessment for prefabricated buildings has not yet been formed. Some scholars have introduced the entropy weight method into the risk identification [8]. At same time, the introduction has broadened the management ideas of prefabricated buildings [9]. Some scholars use the fuzzy a risk assessment prefabricated buildings apply the LEC realize the quantitative calculation of risk and risk assessment classification [10]. In terms of evaluation content, most of these studies are aimed at risk management research in the construction stage of prefabricated buildings, but there are relatively few researches on risk assessment of the whole life cycle, and there is a lack of systematic risk evaluation index system; in terms of evaluation methods, either use The generality of the method is poor and cannot be widely applied to engineering practice, or the AHP is used, which is highly subjective.

In view of this, according to the implementation content, it divides the whole life cycle into 5 stages. It is applied to the calculation of the weight of each evaluation index, the Monte Carlo method is used to obtain the evaluation value of each evaluation index, and the uncertain analytic hierarchy process is combined with the neural network to establish model, and verified by engineering examples, providing new ideas for the risk management of similar engineering projects.

**Materials and Methods**

Different from traditional buildings, prefabricated buildings require the cooperation of design and construction operations, which requires higher cooperation among all parties, and the construction method has undergone great changes. The risk management of prefabricated buildings should not only focus on the construction stage, but also the safety management before and after construction [11].
Prefabricated buildings and their characteristics

It meets the functions of use by overlapping the common components produced by the prefabricated factory on the construction site after a standardized design. The construction of prefabricated buildings is an integrated process, with industrial production as the integration core, the integration of structure, maintenance, interior decoration, equipment, and pipelines is realized in engineering, and the integration of planning, design, production and construction participants is realized at the same time [12].

The prefabricated building was developed under the drive of the reform and has the characteristics of industrialization. Prefabricated building means that after the components that have been standardized, they are hoisted by various types of machinery and equipment, and then the components are connected by bolts, nails, post-cast concrete or mortar anchors and other processes. It becomes a safe and reliable building structure with a certain bearing capacity [13]. The classification of prefabricated buildings varies according to different standards, and the existing classifications are mainly based on the differences in the materials and structural forms that constitute the building. Due to the differences in materials and the differences in the combination of different materials, the classifications are: steel bars, reinforced concrete, steel skeleton concrete, section steel concrete, light steel and wood, etc. [14]. According to the different structural stress and materials, there are prefabricated concrete structures, prefabricated steel structures, prefabricated reinforced concrete structures, prefabricated wood structures, etc. The application of prefabricated reinforced concrete structures is relatively mature [15]. Such industrialized production, and is hoisting and splicing through special equipment. The construction process of prefabricated buildings is like building blocks. The industrial production method has vigorously promoted the process and can optimize the production capacity structure.

Risk and project risk

There are various definitions of risk at home and abroad. C. Arthur. Williams, an American risk management expert, defines risk as "the difference of possible results in a given situation" [16]. There are also some domestic scholars who believe that "risk refers to the specific danger that may occur and its consequences". But in summary, all definitions emphasize the uncertainty of risk and the disadvantage of risk. The author believes that risk refers to people in the process of completing something, often do it, resulting failure to achieve such expected effect, resulting in a certain deviation, these uncertain factors refer to risks, the process of risk occurrence such as As shown in Figure 1, the resulting deviation from expectations is the magnitude of the risk, which is usually quantified by the value at risk (R) [17]:

\[ R = \sum_{i=1}^{n} P_i \times C_i \]  

Among them, \( P_i \) represents the probability of the occurrence of risk factor i; \( C_i \) represents the consequence of the occurrence of risk i.
Engineering project risk is that in the process of project initiation, design, construction, etc., due to unforeseen reasons such as economy, technology, human factors, natural environment, etc., the quality, cost, progress or safety of the project is affected, resulting in the failure of project implementation results. Expected requirements. Project risk has the following characteristics:

Diversity. In an engineering project, there may be a variety of risk factors, such as political risk, natural risk, technical risk, etc., and there may be intricate links between these risks. In some cases, a risk will not affect the project, but when two or more of these factors occur at the same time, there will be fatal hazards.

Universality. Risks exist in general engineering projects, and in the same project, risks not only exist in a certain stage, but it is. There are risks in any link of an engineering project, but some risks have a relatively small probability and loss and can be ignored, while some risks will cause greater losses to the project.

Uncertainty. For engineering projects, each project is unique, and different project risks are related to the project itself, so it is difficult to accurately judge the time when each risk factor occurs, the consequences, and even whether it occurs in the future project implementation process. It's hard to be sure.

Linkage. The impact of engineering project risk on the project is chained, often not only affecting a certain stage or a certain aspect. For example, if a political risk occurs after a project planning decision, the project may not be carried out smoothly, or there may be errors in the design due to technical risks. If it is found, it will stop work and make corrections, which will affect the entire construction period and lead to an increase in costs; if it is not found, it will affect the quality of the project. and performance.

Regularity. Although each engineering project is unique, the construction methods are similar, and risks occur regularly at the same stage. The time of occurrence of risks and the harm caused to the project can be judged based on previous project experience. Therefore, as long as managers have a correct understanding of risks and awareness of risk management, they can avoid risks or reduce losses to a minimum.

Risk management refers to a systematic management method that uses scientific theories and methods to predict and analyze possible risks and propose corresponding solutions in order to ensure the smooth realization of project objectives [19]. Project risk management is to predict and identify the risk events that may be encountered establish a risk analysis model through the judgment of experienced people and scientific mathematical methods to determine the probability of risk occurrence, possible consequences and losses, and reasonable Use some measures, technologies and management methods to control risks, properly reduce the harm caused by risks, and reduce losses. It is in the construction [20-22].

Risk management mainly includes risk identification, risk assessment and risk response, as shown in Figure 2. According to the steps, and risk response includes risk decision-making and monitoring.
Considering the interconnection between risk factors and the comprehensive impact on the project, determining the risk level and comparing it with the benchmark level to determine whether the risk is within an acceptable range. The risk assessment is here [23-25]: determine the baseline level - determine the risk level - compare - determine whether it is acceptable. Compared with risk analysis, which only considers the influence of a single factor, risk assessment pays more attention to the system and the overall situation. Starting from the project as a whole, based on the perspective of systems engineering, analyze the parallel, sequential, causal and other connections between these factors, through the risk ranking, clearly understand the level of these risks, and control key risks in a targeted manner. There are three types of risk assessment methods: qualitative, quantitative, and qualitative and quantitative. Commonly used methods are subjective method, decision tree method, AHP, fuzzy comprehensive assessment method.

It is one of the most commonly used methods in engineering project risk assessment, and its essence is a digital simulation method using statistical experiments. The number of random variables is extracted to calculate random variables that obey various probability distributions, and then approximate solutions of complex problems are obtained through functions simulated by statistical experiments. The steps of risk assessment using this method are shown in Figure 3.

The Monte Carlo simulation process is simple and flexible, and can analyze the impact of changes in multiple risk factors on the project. However, the premise is that these factors are independent of each other and take values in a continuous distribution. This condition is difficult to meet in the application of actual engineering projects. Therefore, the accuracy of Monte Carlo simulation method in engineering risk assessment needs to be improved.
Characteristics of prefabricated building risk management

The project management of prefabricated construction is a complex and large-scale systematic project. It is inevitable that there will be interference from uncertain factors during the implementation process. Once problems occur in the project, it is difficult to make up for it in the follow-up. A correct understanding of the importance of risk management will greatly ensure the success of the project. The basic goal is achieved, and the maximum project benefit is obtained with the smallest possible investment. In my country is not yet mature. At this stage, in addition to pursuing the progress of construction technology and science and technology, we also need to constantly explore the management problems existing in the whole life cycle, in-depth understanding of potential project risks and obstacles to the development of prefabricated buildings. factors, laying a theoretical foundation for promoting the risk management process. for risk management mainly has the following characteristics:

Changes in construction methods. Traditional buildings are mainly completed by cast-in-place operations, and all risk factors affecting the project objectives are concentrated in the construction stage. As long as quality defects are prevented during construction, construction materials are sufficient, and casualties on site are avoided, risks can be minimized. The difference between prefabricated buildings and traditional buildings is that on-site wet operations are reduced. Through standardized design, most of the components are prefabricated, and then connected into buildings through on-site installation. Therefore, the risk management object has changed from transportation with the assembly process.

Construction sites increased. The construction activities of traditional buildings are mainly concentrated on the construction site, while more activities of prefabricated buildings are carried out in component processing plants. The increase of construction sites makes discontinuous, and the management of both on-site and processing plants makes project risk management more difficult.

Participants increased. There are more links in the implementation process of prefabricated buildings. If the connection between the links is not smooth enough, the construction period will be extended accordingly. Project participants also have more manufacturers and transport units than traditional construction projects. The lack of smooth development is immature. Although the prefabricated building was proposed earlier in my country, it has not been fully developed. The design unit is not very experienced in the disassembly and assembly of components, and there are often design errors, coupled with construction such as node connection. The technology is not developed enough, and the target management of the project is not mature enough. These reasons make the risk management of prefabricated buildings more difficult.

Results and Discussion

The factors affecting the impact of building safety involve various aspects, and the specific indicators are various, and the relationship between the safety status of the building and each influencing factor is not a simple linear relationship, so the traditional linear model can no longer accurately reflect the safety evaluation and influencing factors. The internal connection between them makes it impossible to meet the high-precision evaluation requirements. In order to correctly find the internal connection, many experts and scholars currently use nonlinear methods such as gray prediction model and multiple linear regression model to simulate and predict. Although the accuracy number of variables involved, it leads to fluctuations, increased randomness and randomness, thereby reducing the prediction accuracy of these methods and limiting the applicability of the model. Therefore, an effective, scientific and practical method
is needed for the safety evaluation of prefabricated buildings, which can effectively overcome
the complex and uncertain characteristics of the safety degree and its influencing factors, so as
to achieve the requirements of high precision.

The Monte Carlo simulation method is mainly used to evaluate the impact of multiple non-
deterministic risk factors on the overall project objectives. The simulation process is simple
and flexible, and can analyze the impact of changes in multiple risk factors on the project.
When estimating the risk of prefabricated buildings, this paper adopts the Monte Carlo method,
analyzes and sorts out a large number of accident cases, obtains the risk evaluation system and
risk coefficient, and establishes the Monte Carlo model for risk factor analysis. Risk
identification needs to collect a large amount of internal and external information of the project,
then find the source of risk, screen and screen the risk factors, and then establish a risk list after
confirmation. There are three main sources of construction risk in this paper. The first is the
collection of literature and materials. By searching for the previous relevant papers, materials
and expert opinions, a comprehensive summary of possible construction risk factors may occur.
The second is on-site investigation, conducting on-site investigation on a prefabricated steel
structure affordable housing project, and collecting relevant information and materials
involved in the construction process, mainly including feasibility study reports, engineering
geological survey reports, design drawings, construction organization design, construction-
related normative standards, etc. Secondly, the opinions of front-line managers and operators
during the construction process are collected, and the risk list is further supplemented and
improved. The third is to collect engineering data and materials of the same type of projects,
and summarize and sort out construction risk accidents that have occurred in the project
through questionnaire surveys for completed projects.
Monte Carlo method is a numerical simulation method based on the theory of probability and
statistics, through a large number of random sampling to carry out risk probability analysis. On
the basis that the probability distribution of random variables is known or conforms to the
assumed distribution, a set of random numbers is obtained by sampling random variables, and
then this set of random numbers is substituted into the analysis model one by one to obtain the
project evaluation index; When there are enough, the probability distribution of the project
evaluation index can be obtained, so as to provide a reference for the feasibility of the project.
Based on the establishment of the Monte Carlo model, the risk coefficients of the basic risk
factors are sampled, and after a set of inputs is obtained, it is transmitted upward in the model
to obtain an output of construction accidents; run 106 times, the overhead event risk can be
obtained The probability distribution of the coefficients, through the study of the probability
distribution, can determine the safety of the buildings in the area.
The determination process of the basic event risk coefficient obeys the n-fold Bernoulli
distribution; according to the theory of probability and statistics, the risk coefficient (event
damage probability) of each event obeys the beta distribution, and the formula is expressed as:
\[
f(x; \alpha, \beta) = \frac{1}{B(\alpha, \beta)} x^{\alpha-1}(1-x)^{\beta-1} \quad (2)
\]
\[
E(x; \alpha, \beta) = \frac{\beta}{\alpha + \beta} \quad (3)
\]
On the basis of establishing the evaluation system, it is used to accumulate layer by layer
upwards, from the basic event upwards, according to lower-level event, and W be the weight
coefficient set of the lower-level event:
\[
R = \mu_1W_1 + \mu_2W_2 + \cdots + \mu_nW_n \quad (4)
\]
BP neural network
There are many indicators in the construction safety evaluation model, and there is a nonlinear relationship between safety factors. Based on the ability of BP neural network to process nonlinear mapping and high-speed computing, it can establish dynamic and stable learning according to its own learning and adaptation. Therefore, the BP neural network can effectively solve the problems involved in the safety evaluation model. BP neural network is a gradient-based steepest descent method, which takes the squared error MSE as the objective function, and performs weight training for nonlinear differentiable functions. It is a supervised learning algorithm. Then the neural network calculation method is expressed as the following form.

\[ h_i = \omega_{ji} \cdot x_j + b_i \]  
(5)

\[ o_j = f_i(\beta_j \cdot h_j) \]  
(6)

\[ y_i = v_{ik} \cdot o_i \]  
(7)

Among them, algorithm flow of BP neural network mainly includes two processes: forward propagation.

1) Forward propagation of data:

Such interconnection pattern. As shown in Figure 4, each neuron cell has a corresponding calculation weight. The output value of the input layer in the hidden layer is obtained by performing and weighting the input value, connection weight and threshold. The calculation method is as follows:

\[ \text{net}_1 = \sum_{a=1}^{n} w_{ik} y_i + b_k \]  
\[ z_k = f(\text{net}_1) = \frac{1}{1 + \exp(-\text{net}_1)} \]  
(9)

Next, the hidden layer data is used as the input layer, and the data is passed to the output layer. The output value \( \text{net}_2 \) is weighted and summed by the hidden layer value and the connection weight \( v_{kj} \) between the hidden layer and the output layer, plus the threshold value to still obtained as follows:

\[ \text{net}_2 = \sum_{k=1}^{n} v_{kj} z_k + b_j \]  
(10)

Formula (11) activates the output value to obtain the data of the final output layer.

\[ z_k = f(\text{net}_2) = \frac{1}{1 + \exp(-\text{net}_2)} \]  
(11)

2) Error back propagation

(E) is used to measure the size of the error between the actual output code and the expected output Oj. The calculation process is as follows:

\[ E = \frac{1}{2} (d - o)^2 = \frac{1}{2} \sum_{j=1}^{n} (d_j - o_j)^2 \]  
(12)

The error signals obtained at each layer are used to adjust the weights of the connections between neurons. Equation (13) simulates the process of error back propagation.

\[ E = \frac{1}{2} \sum_{j=1}^{n} (d_j - o_j)^2 = \frac{1}{2} \sum_{j=1}^{n} (d_j - f(\sum_{k=1}^{n} v_{kj} z_k))^2 \]  
(13)

The formula for updating the weight of each connection is as follows:

\[ \Delta v_{kj} = -\eta \frac{\partial E}{\partial \text{net}_2} z_k \]  
(14)

\[ v_{kj} = v_{kj} + \Delta v_{kj} \]  
(15)

Applicability of BP Neural Network in Security Evaluation Model
It train and study the nonlinear mapping connection between a large number of neuron nodes, and has a strong adaptive learning ability, which can effectively construct models that can reflect internal laws. Based on its basic principles and characteristics, BP neural network can effectively solve the problems involved in the safety evaluation model. The following is a discussion for applicability of BP neural network in the safety factor model:

1. The nonlinear mapping has strong approximation ability. The BP neural network can continuously approach the nonlinear function mapping relationship through error correction according to the precision required by the user. In the prefabricated building construction safety evaluation model in this paper, there are many influencing factors and indicators, and the relationship between the original data is very vague and mostly nonlinear. The approximation nonlinear ability of BP neural network can adapt to this situation, which makes BP neural network approximation nonlinear. The accuracy of the fitting prediction of the neural network is higher than that of other methods.

2. Get the optimal solution quickly. The large number of interconnected network structures large-scale data in parallel, realize global real-time information analysis, and can quickly coordinate the relationship of various input information for a specific problem. Computing power to quickly find the global optimal solution. In the safety evaluation model of prefabricated buildings, the aspects and data involved are very huge, which requires this characteristic of the BP network nervous system to speed up the solution of the model and improve the accuracy of the model.

3. Strong fault tolerance. Due to the many factors analyzed and the strong unpredictability, the data is prone to outliers, which easily leads to the lack of data. The distributed storage implemented by the BP neural network can make the system still maintain the overall stability under the influence of a small amount of local data loss, and will not cause the system to collapse and paralyze. Therefore, this feature greatly increases the applicability of BP neural network in the model.

4. Self-organization and self-learning ability. The BP neural network system learned by specific training can turn on the adaptive mode. In the safety evaluation model in the prefabricated building, the system can adjust the self-adaptive and self-learning data through its own mechanism, and store and generalize the information to realize dynamic learning the model. Significance.

Result analysis and discussion

The empirical evidence used in this paper is mainly the prefabricated housing project undertaken by Gansu Construction Investment Group No. 4. The main project is to inspect the prefabricated steel structure affordable housing project in Gansu Jiantou Lanzhou New District. The "Statistical Table 2018" released by the Construction Department on September 16, 2019 collected and sorted out in this article. Due to the differences between prefabricated buildings and traditional construction methods and construction procedures, for example, the reinforcement and cutting work of prefabricated buildings are mainly carried out in prefabricated factories, with a high safety factor. The intensity is high and the number of employees is relatively small, so the original risk assessment model is difficult to fully apply to prefabricated buildings. Therefore, it is necessary to establish a new risk assessment system to help the research work of prefabricated buildings. Combined with the division of construction procedures at home and abroad, the risk assessment.

The work content of the decision-making stage is relatively small, but it has a crucial impact on the whole process of construction. This stage includes feasibility study, project evaluation and project decision-making. The main purpose is to determine the funds, time, benefits and other elements through demonstration and comparison to ensure the feasibility of the project.
Risks in the decision-making stage mainly include: inaccurate investment estimates; inaccurate market demand forecasts; imperfect relevant laws and regulations.

The design process of prefabricated buildings is basically the same as that of traditional buildings, except that the content of prefabricated design is added to each link. The design of traditional buildings is mainly for scheme design, overall design and construction drawing design, while the design of prefabricated buildings is mainly for scheme design + PC scheme design, Overall design + PC overall design, construction drawing design + PC construction drawing design and PC detailed design. The risks in the design stage mainly include: the whole life cycle of the project is not considered in the design; the degree of PC detailed design is low; the design pipeline is not considered enough; the scientific disassembly of prefabricated components; the application of BIM in the whole industry chain; And less.

Construction stage. The construction stage is the key link of the project, including foundation engineering, main engineering, roofing engineering, decoration and equipment installation. The risks in the construction stage mainly include: on-site placement and protection of PC components; inspection of relevant materials and equipment; safety of temporary supports; strength of concrete and grouting materials; lack of construction personnel with hoisting experience;

Operation phase. The operation stage is an important stage to test the construction level and income level. The main work is the maintenance and operation management of the building. The risks in the operation stage mainly include: poor maintenance in the later stage, failure to achieve expected returns, lack of experienced properties, etc.

Using the Monte Carlo experiment method, a random experiment is carried out. Figure 4 shows the results of the risk probability density curve under one of the first-level indicators.

![Figure 4](image.png)

Figure 4 High green density result curve of risk factors under the environmental risk category

The ranking of evaluation index weights is an important part of analyzing it. Through the comparison of ranking, the "contribution value" of index factors to construction risks can be scientifically and reasonably analyzed, and it is convenient for targeted construction risk management measures to deal with risks and reduce the risk. Construction risk has a certain guiding role. The weight analysis of each risk will be here:
Figure 5 Pie chart of the weights of each risk indicator

Figure 5 shows the risk assessment of prefabricated buildings based on BP neural network. On the basis of the above obtained sample input and output, based on the BP neural network model in Section 3, the construction risk of the prefabricated residential project is evaluated through the MATLAB toolbox, as Figure 6 shows the training process of the neural network.

Since the BP neural network selects 20 training sets and 5 test sets randomly from 25 sets of samples when training the initial selection of samples, different samples may cause different errors. In order to ensure the objectiveness and fairness of training, this training selects 5 different random opportunities, and finally takes the average error. The results show that when the number of neurons in the hidden layer is selected to be 5, the final error between the actual output value and the expected value is the difference is 0.0611. Figure 7 shows a comparison chart of the prediction error results of the neural network.
Monte Carlo method was used to conduct experiments to compare and analyze the risk assessment accuracy of matter-element undetermined measurement method. The analysis for risk assessment accuracy of the prefabricated construction project of the method in this paper can reach up to 100%, while the risk assessment accuracy of the project of the other two methods is only 59% and 70% respectively. For risk assessment of prefabricated construction projects is better than that of the traditional method as shown in Figure 8.

**Conclusion**

In order to solve the problem that the fuzzy uncertainty, randomness and nonlinear relationship between the indicators of prefabricated building construction safety evaluation make it difficult for experts to gain insight into all the information of the indicators, thereby reducing the scientificity of the evaluation results, those determine the existing risk factors, and comprehensively analyze them, establish a risk assessment system for prefabricated buildings, and use the BP neural network method to simulate and train various safety factors to form a scientific and effective safety evaluation system. Through the method designed in this paper, specific risks can be found and corresponding measures can be taken, so as to achieve the goal of reducing the risk of prefabricated buildings.
Data availability

The figures used to support the findings of this study are included in the article.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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