Research Article

Key Factors Identification and Path Selection of Enterprise Digital Transformation under Multicriteria Interaction

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Enterprise digital transformation is a must-go phase in today’s market, for both large and small businesses. This is determined by the development of the market economy and people’s consumption concept. However, enterprises will face many challenges and factors in the process of digital transformation. For enterprise managers, it is more difficult to deal with these complex data and factors. Moreover, the digital transformation of enterprises needs to consider more development goals. For small businesses, the digital transformation of a business is even more difficult. This requires a full understanding of the key factors and development paths of the enterprise in the process of enterprise digital transformation. If the key factors of the enterprise and the reasonable development path of the enterprise cannot be fully grasped in the process of digital transformation of the enterprise, it will easily lead to the failure of the transformation of the enterprise. Therefore, in the process of enterprise transformation, it is necessary to fully consider the key factors faced by the enterprise and the reasonable development path of the enterprise. This study uses the multicriteria optimization algorithm and ConvLSTM method to study the key factors and paths in the digital transformation of enterprises. The research results show that the multicriteria optimization algorithm can efficiently handle multiple development goals in the digital transformation of enterprises, and the ConvLSTM algorithm can also accurately predict the key factors in the digital transformation of enterprises.

1. Introduction

With the development of economic globalization, enterprises are facing huge challenges. It needs to abandon the original self-sufficient industrial model, but it needs to face the development model of the globalized economy. At the same time, with the development of the Internet and Internet of Things technology, the development of enterprises should not only be limited to the traditional sales model but also need to use the e-commerce model to improve the development performance of enterprises [1, 2]. The transformation of the enterprise puts forward higher requirements for the management department and the financial department of the enterprise. For the development of today’s enterprises, enterprises need to transform into a digital model. Whether it is a business’s sales or its finances, it faces a huge amount of data. These data are the basis for them to continuously improve their business performance. If an enterprise still adopts the traditional business model, it will face the situation of being eliminated [3, 4]. An enterprise not only needs to improve the quality of its own products but also needs to understand the needs and dynamics of the market in real time, so as to ensure the continuous and sustainable development of the enterprise. If an enterprise still adopts the traditional business model and traditional financial processing model, it will lose a lot of market demand information. There are great real-time changes in the current market demand, and there are also great changes in cooperation in the market. An enterprise can only produce industries with relatively strong strength. There are a lot of changes in cooperation and market demand in today’s enterprises, and these changes will inevitably generate a large amount of data. If an enterprise still adopts the traditional financial management model, it will not only bring huge pressure and problems to the financial staff. It is also difficult for financial personnel to find changes in the economic
model and market demand of enterprises from the data [5, 6]. This requires companies to continuously transform to digital. However, the digital transformation of enterprises is not an easy task. There are many problems and challenges that enterprises will face in the process of digital transformation, which require enterprises to have sufficient financial support capabilities. For the digital transformation of an enterprise, a large enterprise will often stand the test of the transformation process, while a small enterprise will face numerous problems and challenges. Therefore, it is more important to identify key factors and paths in the process of digital transformation of an enterprise. Managers of an enterprise need to efficiently integrate digital transformation with the development needs of their enterprise, which requires managers to be able to discover the key factors and path choices in the process of digital transformation of their enterprise [7]. This is a more critical factor for both large and small businesses.

An enterprise needs to formulate a series of digital transformation strategies according to the real-time changes in the market and the needs of the market, which requires managers to grasp the big data of market changes in real time [8, 9]. However, the big data generated by market changes are massive, and it is difficult for enterprise managers to use their own experience and professional knowledge to discover the rules. This study intends to use a multicriteria interaction algorithm to study the key factors and path selection factors in the process of digital transformation of enterprises [10, 11]. The multicriteria algorithm formulates more influencing factors according to the needs of the research object, and the interaction between these influencing factors will limit the development of the needs of the object [12, 13].

The multicriteria optimization algorithm can restrict multiple factors of the research object to each other to optimize the selection, which can better limit each factor of the research object. The multicriteria optimization algorithm can limit the infinite development of a single factor, and it can better balance the relationship between each factor of the research object [14]. This is because each research object will have multiple limiting factors. If a research object is studied according to a limiting factor, it will cause the attributes of the research object to develop towards a single limiting factor. This will cause large errors and unfriendliness. The multicriteria optimization algorithm can effectively integrate and select multiple limiting factors, which can find the appropriate development direction and attributes for the research object. Multiaccuracy optimization algorithms can be divided into multiattribute decision-making and multiobjective decision-making. Multiattribute decision-making is that it needs to consider the influence of multiple attributes on the same target. The multiobjective decision-making is to consider the impact of multiple objectives on the research object at the same time. Multiobjective decision-making is generally used in the research of enterprise development.

The multicriteria optimization algorithm is applied in the identification of key factors in the digital transformation of enterprises. It will consider multiple objectives that limit the digital transformation of enterprises, and it will also consider the optimal optimization value of these objectives. If, in the process of enterprise digital transformation, it only considers the development of one factor or goal, it will easily lead to the failure of enterprise digital transformation. This is because the development of the market economy is rapid, and it is not only determined by the development goals of an enterprise. Therefore, it is a good development direction to apply the multicriteria optimization algorithm in the research of enterprise digital transformation.

This study will use the multicriteria optimization algorithm to consider the interaction between multiple objectives in the process of enterprise digital transformation. It also applies the method of the neural network to study the identification of key factors in the process of enterprise digital transformation. This research will be divided into five chapters to analyze the feasibility of applying the two methods in enterprise digital transformation. The implications of enterprise digital transformation and multicriteria optimization algorithms are studied in Section 1. The current research status of enterprise digitization is investigated in Section 2. Section 3 introduces the scheme and working principle of the multicriteria optimization algorithm and neural network method applied in the digital transformation of enterprises. Section 4 presents the accuracy of key factor identification in enterprise digital transformation. This study uses statistical parameters such as average error and linear function to analyze three characteristics of enterprise digital transformation. Section 5 summarizes the relevance of enterprise digital transformation.

2. Related Work

With the rapid development of the economy and the advancement of science and technology, the digital transformation of enterprises has been going on for some time. There are huge challenges as well as opportunities here for both large and small businesses as seen through the digital transformation of businesses. There are many factors and development paths that need to be considered in the process of enterprise digital transformation. The key to the success of enterprise transformation is that managers must grasp the key factors of enterprise digital transformation, and it needs to choose the correct route. Numerous studies have been conducted on the digital transformation of enterprises. Wang et al., [15] believed that in the process of digital transformation of enterprises, mature information systems and maintenance methods are needed to support information technology. However, most of the current enterprises do not have such a model or tool to achieve this, which is not conducive to the digital transformation process of enterprises. It uses the semantic analysis model to design an information service system used in the digital transformation of enterprises. The research results show that this computer-aided semantic model is helpful for the application of enterprise digital transformation system. Li et al., [16] believe that there are many places worth exploring in the current enterprise digital transformation business. It uses information technology and proactive capability systems to develop a validation model for enterprise digital transformation. The author believes that these results can guide
enterprise managers on how to make better use of current resources to realize enterprise digital transformation. It also examines the factors that limit the digital transformation of enterprises. It proposes that in the future digital transformation of enterprises, we can try to use big data and artificial intelligence to assist in the realization of the digital transformation of enterprises. Andriushchenko et al., [17] provided an overview of the key factors influencing the digital transformation of enterprises. It studies the key factors of enterprise digital transformation through mathematical modeling, and it proposes some evaluation indicators, such as development factor, development speed, and multiplication factor. Through mathematical modeling, it can obtain the bifurcation point of enterprise digital transformation, which is also the key to the research of enterprise digital transformation. This mathematical model can minimize the risk of enterprise digital transformation failure. Zeng et al., [18] used the company’s listing development data for many years to study the relationship between the digital transformation of enterprises and the mechanism of action. The results of the study show that the digital transformation of enterprises can promote the improvement of factor productivity. Enterprises can improve their total factor productivity by improving their management efficiency. This research provides a certain reference value for total factor productivity and management efficiency in the process of enterprise digital transformation. Zhang et al., [19] believed that the digital transformation of enterprises can promote the improvement of China’s economy, and it can also change China’s business model and economic development model. Through a large number of literature studies, it was found that the digital transformation of enterprises can reduce costs and improve the production efficiency of enterprises. This study also examines the relationship between enterprise digitization and productivity using the dids in difference (DID) model. The research results also proved its research theory. Yang et al., [20] believe that the digital transformation of enterprises will improve the development of enterprises, but it puts forward higher requirements for enterprise finance. It used neural network technology to study the intelligent assessment method of financial risk level in the process of digital transformation of enterprises. It proposes the EFRL-ResNet neural network, and the results show that this model has high accuracy for enterprise financial risk assessment. This study uses a multicriteria algorithm and ConvLSTM method to predict and analyze relevant characteristics in the process of enterprise digital transformation. Compared with existing research, this study introduces an intelligent method for the analysis of enterprise digital transformation.

3. Application of Multicriteria Algorithm and ConvLSTM Algorithm in Enterprise Digital Transformation

3.1. The Significance of Multicriteria Algorithm. In the process of digital transformation, enterprises face many development goals, such as product sales, employee performance, and corporate performance. This is a key factor in the process of digital transformation of enterprises. It needs to comprehensively consider the relationship between these factors. If the enterprise only considers one of these factors, it will easily lead to the failure of the enterprise’s digital transformation [21]. This is because the development of an enterprise is determined by many factors, and it cannot only consider one of them. The traditional management model can easily lead to the failure of the digital transformation of enterprises, because it is easy for enterprise managers to consider only a few key factors. It is also easy to overlook the relationship between different enterprise development factors. The multicriteria optimization algorithm can comprehensively consider the relationship between different factors in the process of enterprise digital transformation. The multicriteria optimization algorithm will also better balance the relationship between multiple objectives. It will not develop in the direction of an optimal goal, and it will find the relationship between multiple development goals of the enterprise. Then, it uses the relationship between the data to balance the relationship between multiple factors. Therefore, the application of multicriteria algorithms in the process of enterprise digital transformation is a meaningful study.

3.2. Application of Multicriteria Algorithm in Enterprise Digital Transformation. The goal of this research is to use the multicriteria optimization algorithm and the ConvLSTM algorithm to study the key factors in the process of enterprise digital transformation and the identification and prediction of key factors. The multicriteria optimization algorithm will search for the optimal value of the relevant factors in the process of enterprise digital transformation. The ConvLSTM algorithm will predict the spatiotemporal characteristics of these key factors in the digital transformation of enterprises. Ultimately, it will guide enterprise managers to discover the key factors of enterprise digital transformation and the development trend of these key factors, which can also better guide enterprise managers to discover the optimal development path of enterprise digital transformation. Figure 1 shows the application scheme of the multicriteria optimization algorithm and the ConvLSTM algorithm in the process of enterprise digital transformation. This research will map the path of enterprise digital transformation by extracting the characteristics of enterprise performance, employee performance, and enterprise sales in the process of enterprise digital transformation. The result of this prediction is the path of enterprise digitalization, which will be provided to enterprise decision-makers. First, for the training phase of the multicriteria optimization algorithm and the ConvLSTM algorithm, it needs to collect more data sets related to enterprise development. This study mainly analyzes the impact of three key characteristics of product sales, employee performance, and enterprise performance on the digital transformation of enterprises. These three related characteristics of enterprise digitization are the limiting factors for multicriteria optimization algorithms. The relevant data of these three features will be learned and
trained by a multicriteria optimization algorithm, which will find the optimal weights affected by these three features. Then, the relevant data of these three features will be input into the ConvLSTM neural network in the form of time series to extract the spatiotemporal features of the digital transformation of enterprises. These characteristics will be the key factors guiding the digital transformation of enterprises. The neural network method can learn the development trend of three characteristics, which can better guide the development trend of key factors in the process of digital transformation of enterprises. Through the learning of the above two algorithms, it can output relevant data to guide enterprise managers to manage digital transformation.

Multicriteria optimization algorithms mainly include multiattribute optimization algorithms and multiobjective optimization algorithms. Multiobjective optimization algorithm is a common optimization algorithm in enterprise management. It can fully take into account the related influences and mutual constraints between multiple development goals of enterprise development. In this study, a multiobjective optimization algorithm was selected to analyze the current constraints in the process of enterprise digital transformation. Figure 2 shows the workflow of multicriteria optimization algorithms in enterprise digital transformation. It can be seen from Figure 2 that the multicriteria optimization algorithm mainly includes three layers, which are mainly target layer, criterion layer, and object layer. The target layer refers to the best trends in the digital transformation of enterprises. The object layer is the three influencing factors of product sales, employee performance, and enterprise performance that limit the digital transformation of enterprises. These studies also set up three impact factors.

In the calculation process of the multicriteria optimization algorithm, it will involve the distribution of weights. The three related factors of enterprise digital transformation will be continuously given different weights, and then, it will find the optimal weight distribution by comparing the distance between data. Since there are many weight operations, this requires the verification of weight consistency. Equation (1) and (2) show the process of weight consistency check.

Equation (3) shows a measure of the consistency verification ratio. In general, it requires the value of CR to be CR < 1. If CR > 1 occurs, this requires modification of the decision matrix. Otherwise, it is difficult for the multicriteria algorithm to find the exact optimal value of the three related factors in the digital transformation of enterprises.

$$CI = \frac{\lambda_{\text{max}} - n}{n - 1},$$  \hspace{1cm} (1)

$$\lambda_{\text{max}} > n,$$  \hspace{1cm} (2)

$$CR = \frac{CI}{RI},$$  \hspace{1cm} (3)

For the adjustment of the judgment matrix, there will be various schemes. Equation (4) shows how the averaging method adjusts the weight matrix. Equation (5) shows how the geometric mean method adjusts the weight matrix. In general, it can adjust the weight matrix through these two methods, which is to adjust the value of CR to CR < 1 by the system.

$$\omega_i = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}},$$  \hspace{1cm} (4)

$$\omega_i = \left( \frac{1}{n} \prod_{j=1}^{n} a_{ij} \right)^{1/n},$$  \hspace{1cm} (5)

3.3. Application of ConvLSTM Algorithm in Enterprise Digital Transformation. Enterprise digital transformation is a long-term process, and its development process has a strong correlation with time. The multicriteria optimization algorithm only considers the correlation between the three factors of enterprise digital transformation. But it does not adequately account for the time dependencies in the digital transformation of enterprises. Therefore, this study uses the ConvLSTM algorithm to study the temporal correlation between factors such as product sales and employee performance. Figure 3 shows the process of the ConvLSTM algorithm in extracting the temporal characteristics of factors related to enterprise digital transformation. It can fully memorize the influence of the historical state information on the relevant factors of enterprise digitalization on the current state information. This fully takes into account the temporal correlation between factors in the digital transformation process of enterprises. The LSTM method can only predict the temporal characteristics of enterprise digitization-related
features, and it is difficult to extract the spatial characteristics of the enterprise digitization process. The ConvLSTM method adjusts the dot product operation in the LSTM method to a convolution operation, which can extract the spatiotemporal features of enterprise digitization.

For the calculation process of ConvLSTM, the loss function is a function that must exist, which can calculate the gap between the predicted value and the actual value. The weights can continuously find the smallest loss function through this difference. Equation (6) shows the calculation process of the loss function used in this study, which is a loss function calculated by the mean square error.

\[
L = \text{MSE}(\{q_{\text{real}}^k, q_{\text{pre}}^k\}) \quad \text{Equation (6)}
\]

Equation (7) shows the calculation criteria for the forget gate. Forgetting gate can selectively forget the historical state information of enterprise digitization-related features, and it can retain information that is relatively relevant to the current state information, which can continue the temporal characteristics of enterprise digitization features.

\[
f_t = \sigma(w_f \cdot [h_{t-1}, p_t] + b_f). \quad \text{Equation (7)}
\]

Equations (8) and (9) show the calculation criteria for the input gate. The input gate is responsible for inputting the current state information of enterprise digitization as well as important historical state information. It is also an optional input for current state information.

\[
i_t = \sigma(W_{xi} \cdot x_t + W_{hi} \cdot h_{t-1} + W_{ci} \cdot C_{t-1} + b_i), \quad \text{Equation (8)}
\]

\[
f_t = \sigma(W_{xf} \cdot x_t + W_{hf} \cdot h_{t-1} + W_{cf} \cdot C_{t-1} + b_f). \quad \text{Equation (9)}
\]

Equations (10) and (11) describe the calculation criteria for the output gate. It is responsible for outputting the relevant temporal features of the fused enterprise digitalization to the next layer of the network.
\[ o_t = \sigma(W_{xo} \cdot x_t + W_{ho} \cdot h_{t-1} + W_{co} \cdot c_t + b_o), \quad (10) \]

\[ h_t = o_t \odot \text{ELU}(C_t). \quad (11) \]

4. Result Analysis and Discussion

This research will use the multicriteria algorithm and the ConvLSTM algorithm to analyze and study the identification of key factors in the process of enterprise digital transformation. This research mainly selects three main factors involved in the process of digital transformation of enterprises, including product sales, enterprise performance, and employee performance, for accuracy analysis. In order to improve the accuracy of the research, the data selected in this study come from the actual data of many enterprises in Beijing as training set and test set for analysis. Beijing has various types of small- and medium-sized enterprises and large-scale enterprises, and the transformation of enterprises is relatively active. The characteristics of the enterprise data set in Beijing can better represent the characteristics of the digital transformation of most enterprises. In the process of data collection, it is inevitable to encounter data missing and data inaccuracy, which requires data preprocessing. In this study, the missing data will be filled with 0, which will ensure that the data will not report errors during multicriteria calculation. For data preprocessing, it adopts a normalized processing method. In the end, the three related characteristic data in the digital transformation of enterprises will be processed into data of the same distribution and the same interval, which will ensure the normal calculation of the data in the neural network.

In this study, the multicriteria algorithm is calculated and processed on the data before the ConvLSTM algorithm. Moreover, the calculation of the multicriteria algorithm requires that the value of CR satisfies CR < 1. Therefore, this study first analyzes the CR value of three characteristics in the digital transformation of enterprises. The similarity index is an important evaluation index of the CF algorithm. Only the closer the data value of the similarity index is to 1, it shows that the application of the CF algorithm in the process of enterprise digital transformation is effective. Figure 4 shows the three CR values involved in the process of enterprise digital transformation. From Figure 4, it can be clearly seen that the CR values of the characteristics involved in the digital transformation of the three types of enterprises are all less than 1, which indicates that the multicriteria algorithm is more feasible in the constraints of product sales, employee performance, and enterprise performance in the digital transformation of enterprises. Moreover, the CR values of these three features are relatively close, which means that the weight values of the multicriteria algorithm are distributed evenly in the distribution of the three features. This is a relatively successful constraint. If the CR values are scattered among different features, it means that the weights of different features are unbalanced by the multicriteria algorithm. This may be determined by the unsuccessful decision of the multicriteria algorithm.

However, the maximum CR value of the three characteristics of enterprise digital transformation is 0.95, and the minimum CR value is 0.91. This is a relatively balanced distribution, which also shows the feasibility of multicriteria algorithms in optimizing enterprise digital transformation-related characteristics and success.

In this study, the ConvLSTM algorithm is used to predict the three characteristics of enterprise digital transformation, and the prediction accuracy can provide better guidance for enterprise managers. If the accuracy of the forecast is high, it can provide business managers with the development of business-related factors. This can guide enterprise managers to make decisions about the path in the digital transformation of enterprises and provide greater information. Figure 5 shows the forecast errors of three factors: product sales, employee performance, and corporate performance in the process of enterprise digital transformation. In Figure 5, A represents employee performance characteristics. B represents the sales characteristics of the business. C stands for the characteristics of enterprise performance in the process of enterprise digital transformation. In general, the ConvLSTM algorithm can accurately predict the three characteristics of enterprise digital transformation. The largest prediction error is only 2.21%, which is already within an acceptable and reasonable range. This error can also allow business managers to have enough information to make decisions about the development path of their digital transformation. The largest sources of forecast error are related characteristics of firm performance. The volatility of corporate performance is relatively large, which is related to more characteristics. This leads to more errors. The smallest forecast error is only 1.71%, and the reason for this small error is that there is less volatility in employee performance in different time periods. The characteristics of this enterprise digital transformation are relatively easy to predict. Overall, the ConvLSTM algorithm can successfully predict three characteristic factors of enterprise digital transformation.

In order to be more intuitive, the ConvLSTM algorithm can predict the effect of three factors in the digital
transformation of enterprises. This study shows the prediction effect of the ConvLSTM algorithm, respectively. Figure 6 shows the prediction error of employee performance in the digital transformation of enterprises for 15 different sets of data. Overall, the prediction errors for the 15 different sets of data are all distributed within 3%. Most of the forecast errors for employee performance are distributed within 2%. There are only 3 sets of data whose prediction error exceeds 2%, which is only one-fifth of the sample. There are also 4 sets of data with prediction errors of less than 1%, and this part of the error accounts for about a quarter. Overall, the ConvLSTM algorithm can accurately predict the characteristics of employee performance. This kind of error can better guide enterprise managers to identify the key factors of enterprise digital transformation and the development direction of the path.

The linear correlation coefficient can reflect the distribution and fit between the predicted value and the actual value of the enterprise’s digital transformation performance. Figure 7 shows the distribution of linear correlation coefficients of enterprise performance factors in the process of enterprise digital transformation. If the data points of firm performance are distributed above the linear function, it means that the predicted value of firm performance is greater than the actual value of firm performance characteristics. In general, the criterion for a linear function is the distribution of the linear function, the black line in Figure 7. If the data points of the enterprise performance characteristics are distributed on both sides of the linear function $y = x$, it means that the prediction effect of the enterprise performance characteristics is better. From Figure 7, it can be clearly seen that the predicted value of the enterprise characteristics of the digital transformation of the enterprise is in good agreement with the actual value. All data points are equally distributed on both sides of the linear function. This result is confident enough to guide the identification of key factors in the digital transformation process of enterprises.

For a company, product sales are often the most concerned. Figure 8 shows the distribution of predicted and actual values of product sales characteristics in the process of digital transformation of enterprises. In Figure 8, the green area represents the distribution of prediction errors between the predicted value and the actual value of the product sales characteristics of the digital transformation of the enterprise. In general, the ConvLSTM algorithm can fully mine the characteristics of product sales, which can make the predicted value of product sales more consistent with the actual value. Although product sales have a greater relationship with market changes, it also has greater fluctuations. However, the ConvLSTM algorithm can mine the peaks and fluctuations of the sales characteristics of different groups of products. The green area represents the error between the predicted value of product sales and the actual value. It can be seen from Figure 8 that the area of this part is also relatively small. This shows that the ConvLSTM algorithm
algorithm and the ConvLSTM algorithm have relatively successful applications in the digital transformation of enterprises. It cannot successfully realize the constraints of three important factors in the digital transformation of enterprises, and it can also achieve accurate prediction of the three characteristic factors. For the multicriteria optimization algorithm, the distribution of CR values is relatively balanced, and all CR values are less than 1. This shows that the multicriteria algorithm can balance the three factors that constrain the digital transformation of enterprises. For the ConvLSTM algorithm, it can more accurately predict the values of three characteristics of employee performance, enterprise performance, and product sales in the digital transformation of enterprises. All errors are distributed within 3%. The largest prediction error is only 2.21%. In general, the multicriteria optimization algorithm and the ConvLSTM algorithm can successfully guide enterprise managers to predict the key factors of enterprise digitalization and select the correct path. Once the multicriteria algorithm and big data algorithm model are trained, researchers of enterprise digital transformation can only provide relevant data such as enterprise performance and employee performance, and then, it can obtain the relevant path of enterprise digital transformation.

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 conflicts of interest.

References


