Research on the Construction Mechanism of Enterprise Forecasting Ability-- Case study on improving prediction accuracy based on Lenovo

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Abstract. Enterprises are facing both new opportunities and severe challenges in a complex market environment. Improving forecast accuracy is key to improving your bottom line. This paper takes the practice process of Lenovo Group as a case study to explore the construction mechanism of enterprise forecasting ability. This paper finds the establishment of database management, the adoption of general forecasting methods, and the application of multi-level demand collaborative forecasting technology. All of them are conducive to reducing the forecast error rate. This paper analyzes Lenovo Group's efforts to improve the problems of data islands and data breakpoints in the past. It innovates some ways and methods. Not only provides a reference for other enterprises to improve but also reduces the bullwhip effect. They are making the resource utilization of the supply chain more sufficient, and being more conducive to the sustainable development of the supply chain. The research conclusions of this paper have certain references and enlightenments for enterprises to improve the accuracy of forecasting.

1 Introduction

At present, with the advent of the new consumption era, market competition is becoming increasingly fierce, and the market environment is complex and rapidly changing. The market demand is diversified, volatile, and difficult to perceive. It is difficult for humans to accurately grasp the rules, which are full of uncertainties [1]. Although digitalization and intelligence are important means to improve the forecasting ability of enterprises, it is still a big obstacle for enterprises to transform the prediction accuracy and improve the prediction ability of the organization in a complex environment. How prediction technology affects enterprises, and how to effectively predict inside and outside the organization, reduce risks, and reduce the bullwhip effect is a key issue that traditional enterprises are concerned about [2].

In the context of the information age, to ensure that they can take the lead in the fierce market environment, enterprises pay more and more attention to the information generated by operations and the social information related to their development. To improve the efficiency of information collection, analysis, and integration, and achieve the goal of enterprise information data integrity and consistency [3]. At the same time, the distributed storage method can also be used to establish a database to form an integrated management of the enterprise.

Furthermore, based on the results of user cluster identification, a conditional residual simulated load probability prediction model was proposed to predict the load stratification probability to achieve refined power consumption management for users [4]. Companies can use this approach to make probabilistic forecasts [5].

This paper uses a case study method to comprehensively analyze the case enterprises, aiming to explore the construction of enterprise forecasting capabilities in the complex and volatile era. In this paper, Lenovo Group is a representative company in improving the accuracy of forecasts. Lenovo Group has been known for its excellent global supply chain operation capabilities and has been named one of the Gartner Top 25 Global Supply Chain for 7 times. In the new era, Lenovo has been committed to promoting the digital and intelligent development of its supply chain through self-developed advanced technology. It has accumulated rich technical achievements、 practical experience in the prediction of supply chain supply and demand management. Therefore, Lenovo's experience can help other companies improve and refine their forecasting management [6].

2 Establish database management

Lenovo set up a big data center shared by the front and back ends by establishing database management[7],

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which is conducive to enhancing the accuracy of the prediction, and is effective in breaking data islands. At the same time, Lenovo is capable of combining with advanced digital means and technology, and excavating data application scenarios as well. These are beneficial to business development.

As shown in Fig 1, Lenovo mobile device supply chain(MDSC) through systematic design. Lenovo sets up a full life cycle data management system of the integrated management system, which contains data collection、governance、analysis、application, and so on dependent on the company's IT platform. The system covers R&D quality、supplier quality、manufacturing quality、After-sales quality to enable intelligent data-driven quality decisions. The system takes data life cycle management as the main line. Through the Total Quality Management project, Lenovo has established a unified and shared big data center at the front and back ends to effectively break down data silos. At the same time, it can also combine advanced digital means and technologies to explore data application scenarios and support business development. This innovative practice provides a new paradigm for quality business data management, realizes end-to-end quality data management, maximizes the value of quality data, and promotes the robust development of a digital supply chain. Finishing the construction of five steps, including the establishment of organizational systems、taking inventory of data assets、building a data management platform、designing data models, and providing data services and applications.

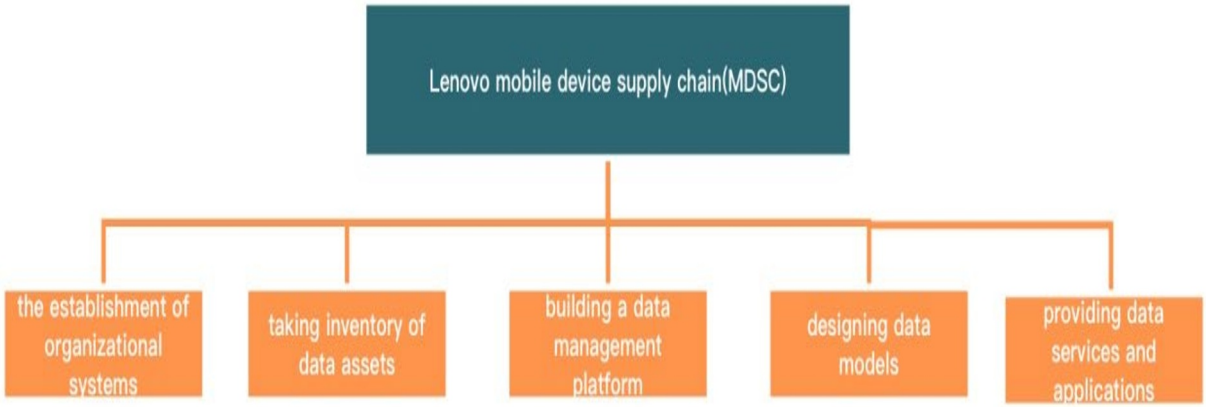

Fig 1 Lenovo mobile device supply chain（Photo/Picture credit : Original）

This innovative practice provides a new paradigm for quality business data management and achieves quality end-to-end data management. Moreover, it maximizes the value of quality data. What's more, it not only puts resilience development of the digital supply chain but also reduces the prediction error rate.

3 Probabilistic prediction

Based on rich business data sources, Lenovo uses feature engineering technology to build a large quantity of effective feature data[8]. Lenovo through the processing of raw data and business-related feature extraction, trains and predicts in machine learning. Numerical features、Category type features and text features are processed by feature engineering technology, resulting in those features that can better reflect the characteristics of the business. Improving the predictive power and accuracy of the model. This includes the static characteristics of product and store attributes, as well as store positioning. Legal holidays and the dynamic time characteristics of the predictor's value during the historical period are also taken into account. Lenovo takes the periodicity of time series and the correlation and difference between different sequences. Raw time series data is largely enriched. The subsequent learning process is sped up as well.

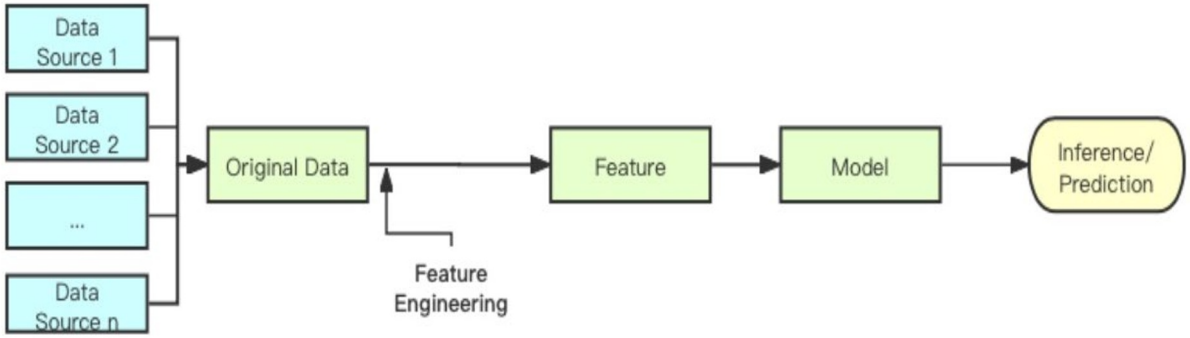

Fig 2 Flowchart of feature engineering technology（Photo/Picture credit : Original）

Based on feature engineering technology, as shown in Fig 2, Lenovo based on the Deep AR model[9], Lenovo fits the distribution parameters directly, and provides an introduction of time series prediction results utilizing reasonable hypothesis probability analysis form. Lenovo takes advantage of the Deep AR model for deep learning, which can capture the complex patterns and trends of the time series data.

This provides more accurate predictions. Under the distribution assumption of a Zero-inflated Negative Binomial, output each possible outcome and its corresponding probability value. Measure the possibility of possible outcomes true. Based on the output of probabilistic prediction, it can be used in a variety of flexible ways. Such as taking the output with the highest probability as the optimal predicted value, providing a prediction interval in the condition of giving different confidence levels, or according to select different prediction quantiles based on actual service scenarios as optimal estimated value. Then, Lenovo's prediction accuracy and reliability are improved. This is conducive to Lenovo's Accurate decision-making in Sales Forecasting and Demand Forecasting. In addition to, the cost of inventory and the risk of the supply chain are reduced, and the competitiveness and efficiency of the business are enhanced.

4 Probabilistic consistency hierarchical prediction under multilevel structure

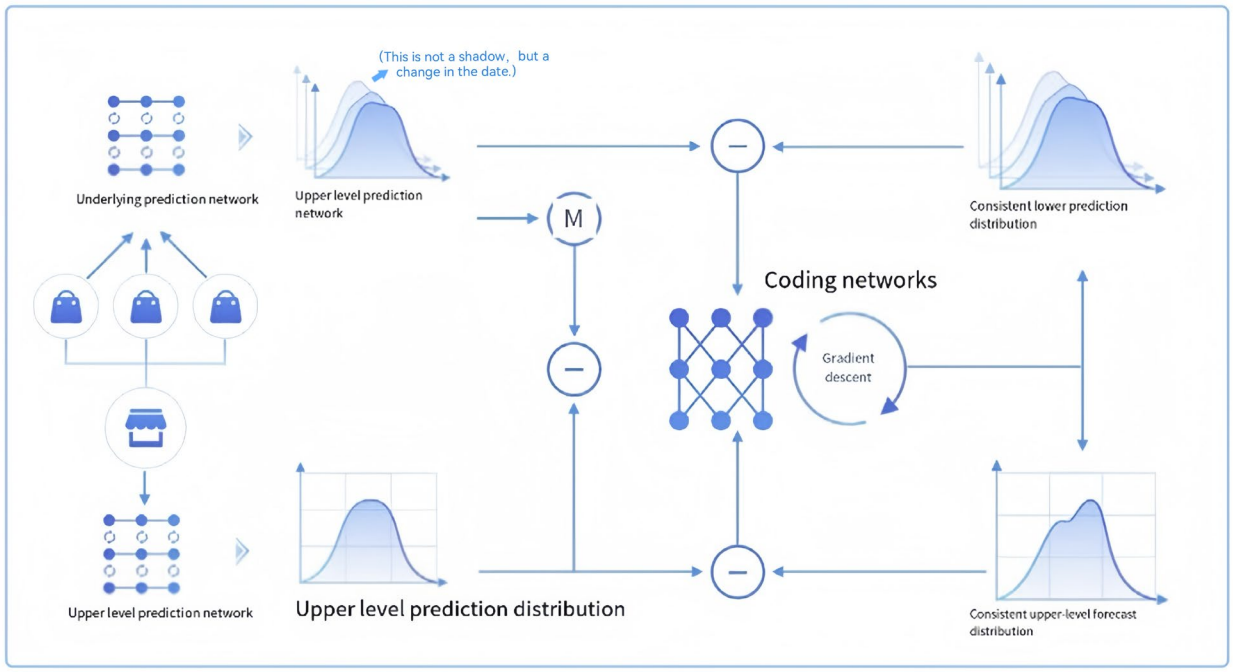

Fig 3. Multi-level demand collaborative forecasting technology algorithm framework[10]

Lenovo uses multi-level demand collaborative forecasting technology to optimize demand forecasting associated with multiple levels, ensuring hierarchical consistency of prediction results and improving overall prediction accuracy [11].

The algorithm framework is shown in Fig 3. Upper level prediction network is not a shadow, but a change in the data. First, the probability of collaborative demand prediction is calculated for each layer's requirements, and the model's parameters for probabilistic prediction are output.

Then, each layer samples based on the probabilistic prediction model and its corresponding parameters, and maps the sampling points to the consistency space that meets the equal sum at each level through linear mapping. The strategy for this process aims to minimize the error between the predicted and true values.

As well as the distance between predicted values after two sampling mappings in the consistency space. The implementation process uses the stochastic gradient descent method to iteratively optimize the linear mapping parameters in several historical windows, resulting in a more effective mapping function. To facilitate optimizing the stocking plan, the prediction model parameters that satisfy hierarchical consistency are obtained through maximum likelihood estimation. This is done after obtaining hierarchical prediction results for addition consistency, based on the assumed multi-layer joint distribution model.

Probabilistic prediction technology can be applied to multi-layered structures with multiple dimensions and has good performance in complex multi-layered structures with mixed dimensions [12].

This technique effectively uses information between different levels to achieve consistency in probability prediction and is compatible with different mediation modes. It can also be extended to large-scale hierarchical sequence prediction. As an enabler, Lenovo ensures efficient and sensitive supply chain operations through supply chain control towers, supplier collaboration platforms, and blockchain application strategies. As an enabler, Lenovo has also developed a series of digital solutions for the digital transformation of other enterprises and public service organizations to enable technology, service, and management. Based on the case analysis of Lenovo's global supply chain, agility, and ecology are the two starting points for digital supply chain transformation. The two complement each other and work together to maximize the digital transformation of the supply chain.

5 Conclusion

Lenovo has solved the problem of limited data sharing with suppliers and manufacturers during past informatization construction by establishing database management, adopting the method of generalization prediction, and applying multi-level demand collaborative prediction technology. Due to the independent construction of various functional departments and decentralized data storage, data islands have formed internally, leading to inaccurate predictions. This problem has been successfully addressed based on the original foundation.

This paper presents a case study of Lenovo, examining three methods used to improve prediction accuracy and draw conclusions and inspirations. However, there are still some shortcomings. It is important to note that this study only uses a single case, and the universality of the research conclusions needs to be tested with more case samples. Secondly, Lenovo, as a large technology company, has unique advantages in digitalization and intelligence. Its improvement in prediction accuracy is based on these advantages.

However, it is unclear whether this situation applies to other small and medium-sized enterprises with limited resources and traditional enterprises. Further exploration is needed. Finally, regarding research methods, follow-up research can deepen the exploration of improving prediction accuracy through large-sample questionnaires, simulations, and econometric analysis.

Authors Contribution

All the authors contribution equally and their names were listed in alphabetical order.

References

1. Q. He, Y. Ouyang. Hyundai. Mall, **24**, 15-17 (2020)
2. M. Zhang, Y. Zhang, K. Liu, CB, (2009)
3. Y. Zhang, X. Li, Inf. Comput, **35**, 13,235-238 (2023)
4. N. Wu, X. Lu. Inf. Comput, **34**, 15, 27-29 (2022)
5. J. Gu, M. Lu, Electr. Power. Syst. Res, **45**, 5, 71-78 (2019)
6. Sh. Zhan, J. Huang, Q. Yuan. J. Bus. Res, **12**, 9 (2014)
7. Z. Yuan, J. Electron. Sci. Technol., **6**, 9, 144-147 (2022)
8. S. Chen, F. Chen., X. He, U. M. Yuan, G. Xuan, GIM, (2019)
9. S. David, F. Valentin, G. Jan, J. Tim, Int. J. Forecast, **36**, 3, 1181-1191 (2020)
10. Lenovo, Sup. Chai. Int. Decis. Technol. White. Paper, 19, (2022)
11. L. Lee, Math. Comput. Simul, **36**, 5 (2019)
12. J. Li, Sci. Manag. Technol, **43,** 12 (2022)