Research on the Practical Application of Visual Knowledge Graph in Technology Service Model and Intelligent Supervision

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Abstract. The paper analyses the relevant elements of enterprise technical services in combination with the relevant knowledge service requirements of enterprise technology management. On this basis, based on enterprise information extraction technology, enterprise knowledge reasoning technology, machine learning technology, etc., it constructs an enterprise technology service model of knowledge graph. The model is divided into five levels: data acquisition layer, data processing layer, technology fusion layer, technology discovery layer, and technology application layer. The knowledge graph is integrated into the enterprise technology service platform to visualize the organizational form of technology management, which makes the enterprise technology service platform more relevant, and the enterprise business solutions are more intelligent and personalized. The research results obtained in the thesis promote the in-depth and universal development of the enterprise technical service model theory, and provide practical reference for improving the enterprise technical service level.

1. Introduction
The clarion call to build a world power in science and technology has been sounded, and the spring of technological innovation has arrived. "To achieve the two centenaries’ goals and realize the Chinese dream of the great rejuvenation of the Chinese nation, we must adhere to the path of independent innovation with Chinese characteristics, face the forefront of world science and technology, face the main economic battlefield, and face the major needs of the country, and accelerate technological innovation in various fields., Grasp the global technological competition opportunities." It can be seen that technological innovation is the foundation and engine of promoting economic and social development, the pillar and backing of improving China’s comprehensive national strength and international competitiveness, and the focus of competition in the era of knowledge economy. Economic development has issued the call of the times to technological innovation, and technological innovation will maintain the future and destiny of the Chinese nation [1]. In order to empower the intelligent supervision of the company's technology management, this paper determines the key direction of this research based on the selection of supervision technology, which is to carry out the research of the company's intelligent supervision of technology based on big data deep learning and knowledge graph technology.
2. Related Overview

2.1. Knowledge Graph

The knowledge graph is a large-scale knowledge base that connects and stores the knowledge of the world with a unified specification. And the knowledge graph has certain reasoning ability, which can help humans discover new knowledge and facts. Compared with general relational databases, the graph structure of the knowledge map is similar to the structure of human brain organization knowledge, which helps machines to simulate human thinking to process and understand knowledge. Logically, we usually divide the knowledge graph into two levels: data layer and model layer. The data layer is mainly composed of a series of facts, and knowledge will be stored in units of facts. For example, use triples such as (entity 1, relationship, and entity 2) and (entity, attribute, attribute value) to express facts. The pattern layer is built on the data layer, and the data layer is standardized through ontology. Ontology is a conceptual template of structured knowledge base. The knowledge base constructed through ontology library not only has a strong hierarchical structure, but also has a small degree of redundancy.

The knowledge graph construction model is divided into two types: top-down and bottom-up. Top-down refers to defining the ontology library and data model first, and then adding a series of facts to the knowledge base, that is, the model layer and then the data layer. Bottom-up is the preliminary extraction of text analysis data. Driven by data, the pattern layer of the knowledge base is designed, that is, the data layer and then the pattern layer [2]. Most general knowledge graphs adopt a bottom-up construction method, such as Google's Knowledge Vault. However, for vertical domain knowledge graphs, it is necessary to meet specific industry expertise and high-quality data, while coping with complex and changeable business needs, so top-down construction methods are often adopted. The architecture of the knowledge graph refers to its construction model structure, the architecture of the knowledge graph (as shown in Figure 1).

![Diagram of Knowledge Graph Architecture](image)

**Figure 1.** The architecture of the knowledge graph.

2.2. Technical management

An enterprise's technology management system is an integral part of the entire management system, including the organizational structure, methods, processes and resources for implementing technology management. These management elements are controlled and effectively managed by the organization according to the law of technical activities, with the purpose of improving the technical performance and competitive advantage of the enterprise. The organizational structure of technology management
refers to the establishment of technology-related institutions, the distribution of departmental functions, and the clearly defined duties and powers of management personnel at all levels and their relationships.

Method refers to the working procedures and methods of technical management activities, including a set of methods for measuring and evaluating system performance through feedback [3]. The process is a set of related resources and activities that transform input into output, including the technical activity process carried out in each link of the whole process of product and service formation, as well as the review process to ensure that the problem is corrected and the process to implement continuous improvement. Resources refer to personnel, funds, facilities, equipment, etc. The technical management system is an organic whole based on technical resources, with a set of organizational structures, all employees have their own technical responsibilities, work and activities in accordance with prescribed procedures and methods, with the goal of improving the technical competitiveness of the enterprise. Enterprise technology management is a process of interaction between technical processes and management functions. It acts on the technical capabilities of the enterprise, activates the potential capabilities, and transforms them into the technical performance of the enterprise. The enterprise technology management system is a system that transforms technical capabilities into technical performance. It takes technical capabilities as an input variable and uses the function of the system to output the realization of technical performance as a result. The process framework of the role of the enterprise technology management system is shown in Figure 2. Under this framework, build a technical management system based on the management content of each stage of the technical activity process.

![Figure 2. The role process framework of the enterprise technology management system.](image)

3. Enterprise technology management system architecture based on knowledge graph

3.1. Overall structure

The design goal of the "Enterprise Technology Management Data Processing and Analysis Application Framework Based on Big Data Deep Learning" proposed in this paper is to use big data processing technology to deal with the problems of multi-source heterogeneous data, polymorphic information fusion, and difficulty in data interconnection [4]. The continuously growing large-scale enterprise technology management data adopts non-intrusive access technology to realize cross-system information exchange, and adopts knowledge graph to realize the association and integration of
polymorphic data. The whole framework includes four layers, namely the data source layer, the data storage management layer, the polymorphic data processing layer, and the application layer, as shown in Figure 3.

Figure 3. Big data application framework diagram of enterprise technology management based on knowledge graph.

3.2. Data service design based on knowledge graph

3.2.1. Knowledge service. This service is to extract targeted information and knowledge according to human needs from explicit and invisible knowledge resources, and build a knowledge network. The knowledge service of an enterprise refers to the construction of an enterprise knowledge graph to infer the implicit association relationship from the explicit enterprise knowledge.

3.2.2. Data retrieval. This service is to extract data from the database according to user needs, generate a database table or use the search result as a further processing object, and realize database data update.

3.2.3. Statistical analysis. This service is to perform statistical analysis on the integrated data in the form of graphs, explore the problems in the enterprise's technical management, and propose solutions or suggestions that meet the actual problem.

3.3. Enterprise technology management knowledge extraction

The extraction stage of enterprise technology management needs to obtain concepts, entities and relationships from multiple data sources such as databases, texts, and encyclopaedia data to construct an enterprise technology knowledge graph [5]. Because there are many data sources of enterprise knowledge, and there are data overlaps between different data sources, how to use appropriate extraction methods for different types of data sources to obtain high-quality enterprise knowledge is a difficult point in the stage of enterprise knowledge extraction. The enterprise knowledge extraction model designed in this paper is shown in Figure 4.
3.4. Enterprise technology management knowledge storage

Because the knowledge composition and application requirements in the field of enterprise technology management are very rich, it is necessary to research and design a heterogeneous knowledge unified storage architecture that takes into account the speed of various forms of content query and modification operations. The thesis uses the advantages of different types of storage systems such as graph databases, distributed memory databases, distributed document databases, and relational databases to comprehensively store and manage knowledge [6]. The integrated storage method is mainly because: the degree of support of the graph database for large amounts of data has not been verified; it supports the complex use scenarios of the Chinese knowledge graph, especially from the perspective of natural language retrieval.

4. Enterprise technology management capability test model based on visual knowledge graph

4.1. Power function

The thesis assumes that variable $u_i (i=1,2,\ldots,m)$ is the order parameter of the enterprise technology management system, $u_j$ is the j index of the i order parameter, and its value is $X_j (j=1,2,\ldots,n) \cdot A_j, B_j$ is the upper and lower limit of the steady state sequence parameter of the technology management system? Therefore, the effective coefficient $u_j$ of the visualized knowledge graph's utility and technical management ability on the orderly system can be expressed as

$$u_j = \begin{cases} 
(X_j - B_j) / (A_j - B_j) & u_j > 0 \\
(A_j - X_j) / (A_j - B_j) & u_j < 0
\end{cases}$$

Among them, $u_j$ is the contribution of variable $X_j$ to the efficiency of the technology management system? The efficiency coefficient constructed according to formula (1) has the following
characteristics: \( u_j \) reflects the degree of satisfaction of each index reaching the target value, \( u_j \) approaching 0 is the most dissatisfied, \( u_j \) approaching 1 is the most satisfactory, so \( 0 \leq u_j \leq 1 \). Since the utility of the visualized knowledge map and the technical management ability are two different and interacting subsystems in the technological innovation system, the "total contribution" to the ordering degree of the order parameters in the subsystems can be realized through integrated methodology [7]. In this case, the geometric average method and the linear weighted sum method are adopted, and the linear weighted sum method is adopted here.

\[
\begin{align*}
\mu_i &= \frac{\lambda_j u_j}{\sum_{j=1}^{n} \lambda_j} \\
\sum_{j=1}^{n} \lambda_j &= 1
\end{align*}
\]

Among them, \( \mu_i \) is the contribution of the subsystem to the order degree of the overall system, and \( \lambda_j \) is the weight of each index, which is determined by the analytic hierarchy process in this article.

4.2. Coupling degree function

The calculation of the coupling degree should draw on the concept of capacity coupling and the model of capacity coupling coefficient in physics, and extend the coupling degree model of the interaction of multiple systems, namely

\[
C_m = \left[ \frac{\left( \prod_{i=1}^{n} u_j \right)}{\prod_{i=1}^{n} (u_i + u_j)} \right]^{1/w}
\]

According to the above formula, the coupling degree function of the utility of the visualized knowledge graph and the technical management ability can be directly obtained.

\[
C = \left[ \frac{\left( u_{ij} \circ u_j \right)}{\left( \left( u_i \circ u_z \right) \circ \left( u_i \circ u_z \right) \right)} \right]^{1/2}
\]

For equation (4), the coupling degree value is between 0 and 1. When \( C \approx 1 \), the coupling between the utility of the visual knowledge graph and the technical management ability is the largest, indicating that the two ability systems have reached a benign resonance coupling, and the technical management system will tend to a new orderly structure; and when \( C \approx 0 \), The coupling between the utility of the visualized knowledge graph and the technical management ability is the smallest, which shows that the two ability systems are in an unrelated state, and the technical management system will develop disorderly.

4.3. Coupling coordination degree function

Coupling degree is an important indicator reflecting the degree of coupling between the utility of visual knowledge graphs and technical management capabilities of enterprises. It is very important for judging the strength of the coupling between the utility of visual knowledge graphs and technical management capabilities of enterprises, as well as the time sequence interval of the effects, and early warning of the development order of the two. Significance [8]. However, in some cases, the degree of coupling is difficult to reflect the overall efficacy and synergy of the utility of the visualized knowledge graph and the technical management capabilities, especially in the case of comparative studies of multiple companies, the method for determining the upper and lower limits of the calculation of the coupling degree Inconsistent, for example, when doing index satisfaction surveys, some use a five-level scale,
some use a seven-level scale or a ninth-level scale. In this case, relying solely on the coupling degree may be misleading. For this reason, it is necessary to construct a model of the coupling and coordination degree of the visual knowledge graph utility and technical management capabilities. Its purpose is to judge the degree of coordination of the interaction coupling between the technical capabilities and technical management capabilities of different enterprises. The algorithm can be expressed as

$$\begin{align*}
H &= (C \times F)^{1/2} \\
F &= \alpha u_1 + \beta u_2
\end{align*}$$

Among them, H is the degree of coupling and coordination; C is the degree of coupling; F is the comprehensive reconciliation index of the utility of the visual knowledge map and the technical management ability, which reflects the overall synergy effect of the utility of the visual knowledge map and the technical management ability. Let; α, β be undetermined coefficients. According to the previous division of the coupling degree, the coupling coordination degree can also be roughly divided here: (1) when 0<H≤0.4, it is a low degree of coordination coupling; (2) when 0.4<H≤0.6, it is Moderately coordinated coupling; (3) When 0.6<H≤0.8, it is highly coordinated coupling; (4) When 0.8<H<1, it is extremely coordinated coupling.

4.4. Verification of results

Based on the multi-dimensional scale analysis and cluster analysis of high-frequency keywords in enterprise technology management, this thesis uses factor analysis to further demonstrate the frontiers of the research to facilitate explanation. According to the results of factor analysis, the top 8 principal components with a cumulative variance contribution rate of 71.599% are obtained, as shown in Table 1:

| Main ingredient | Original eigenvalue | Variance contribution rate% | Cumulative variance contribution rate% | Research frontier topics |
|-----------------|--------------------|-----------------------------|---------------------------------------|-------------------------|
| 1               | 30.442             | 31.383                      | 31.383                                | The relationship between corporate technological innovation and knowledge management, human resource management, corporate culture, etc. State-owned enterprises, small and medium-sized enterprises, high-tech industries, corporate venture capital, system innovation, knowledge innovation, R&D management, management of multinational companies, etc. |
| 2               | 17.090             | 17.619                      | 49.002                                | Strategic management, organizational learning and supply chain management of high-tech enterprises, industrial clusters, and manufacturing innovation capabilities, etc. |
| 3               | 7.178              | 7.400                       | 56.402                                | Evaluation of technical management capabilities, etc. |
| 4               | 3.856              | 3.975                       | 60.377                                | The relationship between corporate governance and capital markets, etc. |
| 5               | 3.574              | 3.684                       | 64.061                                | Evaluation of technological innovation, etc. |
| 6               | 2.955              | 3.046                       | 67.108                                | Enterprise management model and enterprise performance, etc. |
| 7               | 2.469              | 2.546                       | 69.653                                | The relationship between enterprise informatization |
| 8               | 1.887              | 1.946                       | 71.599                                | The relationship between enterprise informatization |
5. Conclusion
The thesis combines big data computing technology with knowledge map technology, puts forward the "application framework of enterprise technology management based on knowledge map", designs the prototype of "enterprise technology management knowledge map system", and uses big data technology and knowledge map technology to improve the building difficulties in interconnection and "data islands" in business data management. In the context of the gradual increase in the amount of data in the information system, it can effectively improve the efficiency of enterprise technology management.

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