Research on Military Nuclear Safety Knowledge Management Mode Based on Big Data

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Abstract. Knowledge management and nuclear safety culture are naturally linked. Many institutions and scholars have done a lot of research on nuclear safety knowledge management. However, under the condition of big data, military nuclear safety knowledge management still faces many challenges. Through literature review and case analysis, combined with the development of big data technology and knowledge management, the military nuclear safety knowledge management model based on big data can be built from the aspects of big data collection and storage, data mining and knowledge discovery, knowledge exchange and sharing, continuous improvement of management means, evaluation and feedback, which can achieve a virtuous circle of military nuclear safety knowledge in the field or organization.

Keywords: Knowledge Management; Big Data; Nuclear Safety; Management Mode

1 Introduction

In the knowledge economy society, knowledge has become the core of enterprise, society and national development, and replaced capital as the fundamental driving force and competitiveness of enterprise growth [1]. In the nuclear related field, especially in the nuclear power field, relevant institutions and enterprises at home and abroad have generally carried out knowledge management. The International Atomic Energy Agency (IAEA) has established a nuclear knowledge management department (NKM) and issued a series of standards, guidelines and technical documents related to

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knowledge management. Through years of accumulation, IAEA has a large number of databases, special reports, training materials, meeting minutes, etc., forming a huge knowledge base [2]. BNFL has implemented the knowledge management plan since 2005, which integrates the company's key technologies and the tacit knowledge of key experts to form a "knowledge package", and stores the "knowledge package" as a knowledge base to provide technical support for the company's employees [3]. In March 2009, China National Nuclear Power Technology Corporation established the National Nuclear University, proposing to build "one platform", improve "three systems", and promote the "five forces plan". Among them, "one platform" refers to the E-Learning platform for all employees and integrating knowledge management, which is actually the knowledge management platform [4]. However, the research on the application of knowledge management to military nuclear safety is relatively few, and the construction of related knowledge management platform is relatively lagging behind. In fact, the mobility of military personnel is greater. Due to the lack of military nuclear safety knowledge management strategy, the risk of loss of key technologies and experience knowledge is greater. With the development of big data technology, the application of big data related theories to knowledge management has a natural advantage. Gerald Onwujekwe et al. proposed a framework for discovering knowledge from unstructured data such as social networking sites, online forums, discussion boards, comments, audio, images, and videos. They focused on the preprocessing and processing technologies of these data, and gave standard output [5]. Goonettillake Jeevani et al. designed a big data classification and enhanced storage mechanism through the hybrid method of database and ontology cooperation to optimize data and knowledge management, so as to improve the efficiency and accuracy of knowledge discovery and retrieval [6]. Mohamed et al. used big data technology to establish the air quality monitoring knowledge management system, and proposed an ontology based data warehouse model representation method to solve problems such as heterogeneous data sources, so that knowledge management covers all stages of the decision-making cycle [7]. Guo Yajun and others put forward a basic framework for college teaching knowledge management based on big data for college knowledge management. Through the collection and storage of teaching big data and knowledge, mining and development, knowledge sharing, path expansion, and results feedback, teaching knowledge can be effectively used [8]. Under the condition of big data, there is no research on military nuclear safety knowledge management, and it still faces many challenges. This paper focuses on building a military nuclear safety knowledge management model based on big data from aspects such as big data collection and storage, data mining and knowledge discovery, knowledge exchange and sharing, continuous improvement of management means, evaluation and feedback, and hopes to achieve a virtuous circle of military nuclear safety knowledge in the field or organization.

2 Introduction Military Nuclear Safety and Knowledge Management

Knowledge management and nuclear safety culture are closely linked, and they promote each other [1]. For military nuclear safety, a good knowledge management system can effectively promote the construction of nuclear safety culture. In fact, knowledge management and nuclear safety culture are similar in many principles and practices. Figure 1 shows the relationship between military nuclear safety culture and knowledge management. Data, documents, expert experience and other tacit knowledge generated in military nuclear safety management provide resources for knowledge management system, which can promote the formation of nuclear safety culture.

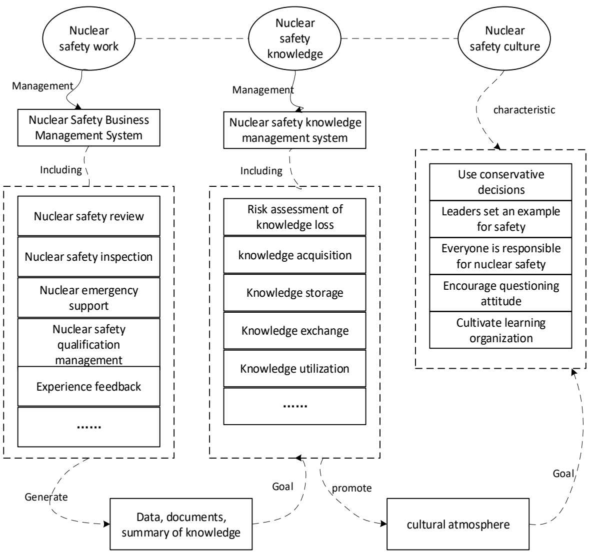

Fig. 1. Relationship between nuclear safety culture and knowledge management

3 Big data based military nuclear safety knowledge management model

Military nuclear safety management serves the whole life cycle of military nuclear facilities, nuclear materials and nuclear related equipment. Massive data is generated in the management process, and all historical data is collected and stored through the business management system, forming military nuclear safety big data. However, these big data are scattered and low-level, which is difficult to transfer, share and use as high-value density knowledge. Therefore, this paper establishes a knowledge management framework model based on big data (as shown in Figure 2), filters, analyzes and discovers knowledge from military nuclear safety data in the sea through big data mining technology, and improves knowledge flow and utilization.

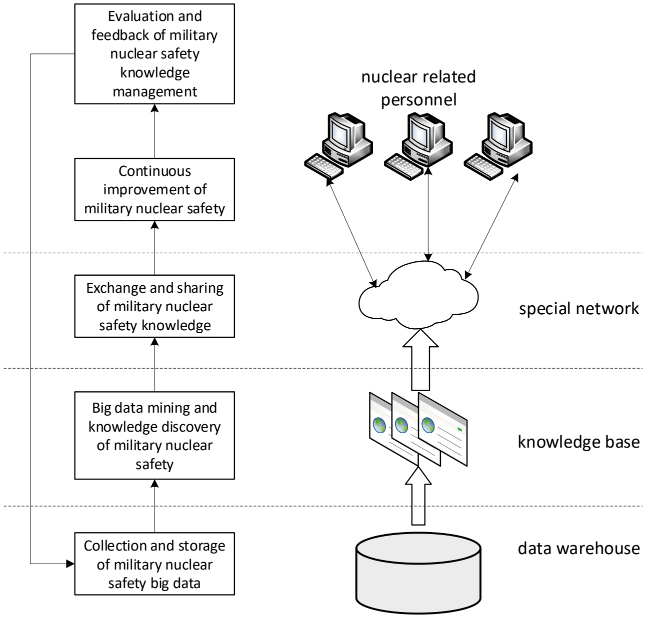

Fig. 2. Example of a figure caption.

3.1 Collection and Storage of Military Nuclear Safety Big Data

The collection and storage of military nuclear safety big data is the basis of knowledge management, mainly including data planning and modeling, data collection, big data storage and processing and other key links.

The military nuclear safety supervision data is complex, which is simplified through big data planning and modeling to provide a basis for data collection. The specific process is shown in Figure 3. First, a big data classification model is developed to classify the data sources according to the basic information, function information, and collaborative linkage information of big data, so as to describe the complex original data according to the basic metadata; Then, a nuclear safety big data collection specification is established to provide a specification for the big data platform to clean and process the original data.

There are structured data, semi-structured data and unstructured data of military nuclear security big data that need to be processed. For structured data, although a variety of database types have emerged, the usual processing method is still to use relational data knowledge base for processing; For semi-structured and unstructured knowledge, Hadoop framework can be used to build Hadoop platform data, distributed database and subject data warehouse. The analysis and processing of unstructured data is completed on the Hadoop platform, and the results are loaded into the distributed database; The distributed database includes a mild summary layer and a detailed data layer. The mild summary layer summarizes data dimensions and users within the subject field, while the detailed data layer splits and associates data within the subject field, and splits and consolidates data according to the subject field division rules; The subject data warehouse includes a high summary level and an information sub level. The high summary level enables correlation and summary calculation between subject fields. The information sub level includes report data, multidimensional data, indicator library and other data. The summary data serves the information sub level to save the data calculation cost and time of the information sub level.

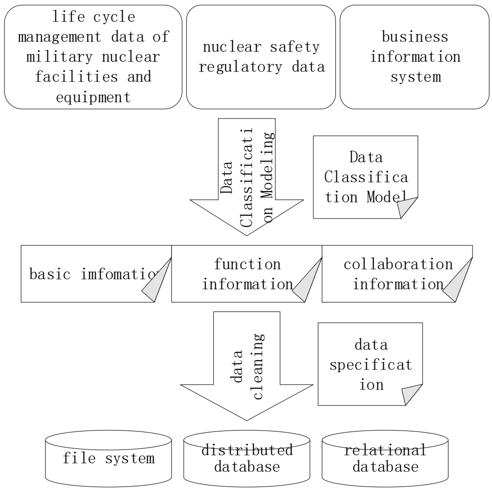

Fig. 3. Military nuclear safety big data planning and modeling process

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3.2 Military Nuclear Safety Big Data Mining and Knowledge Discovery

At present, some mature big data analysis and mining algorithms have emerged, such as deep learning algorithm, association algorithm, clustering algorithm, classification algorithm, etc. The platform focuses on how to select or improve relevant algorithms according to the characteristics of military nuclear security big data to provide model driven knowledge discovery.

The main idea is introduced below by taking the association algorithm based on Apriori algorithm to mine the knowledge related to the storage safety of nuclear facilities as an example. The safety status of nuclear facilities may be affected by such factors as environment and running time, so consider using association rule mining algorithm, combined with the collected running time and environmental data, to find potential association rules between the safety status of nuclear facilities and these factors.

Apriori algorithm is a classical algorithm to solve association rule problems. In Apriori algorithm, the problem of mining association rules is summarized into two sub problems: finding all frequent item sets that meet the given minimum support; on the basis of frequent item sets, all association rules that meet the minimum confidence given by users are generated. By using the Apriori algorithm, mining the strong association rules that meet the minimum support threshold and the minimum confidence threshold between the safety status, running time and environmental data of nuclear facilities, we can find the potential relationship between different factors and the fluctuation of the safety status of nuclear facilities. According to the statistics, the probability of the change of equipment safety degree occurring together with some environmental factors is large, so we can speculate the impact of environmental factors on the operation safety performance of nuclear facilities, and speculate the possible changes and fluctuations of the safety status of nuclear facilities under different environmental conditions.

3.3 Exchange and Sharing of Military Nuclear Safety Knowledge Based on Big Data

Knowledge sharing is the key to knowledge flow. Rely on the private network and promote knowledge sharing and flow through the knowledge management platform. From the spatial dimension of knowledge distribution, it is to promote the flow of knowledge from the rich places to the places with weak knowledge savings, or to share knowledge through big data technology to learn from each other through biased knowledge storage in several places [4]. The distribution of military nuclear safety data and knowledge in different units or organizations is uneven. For example, in troops, nuclear facilities, nuclear equipment operation data, abnormal events or accident cases are relatively rich, while in scientific research institutes, basic principles and cutting-edge theoretical knowledge are relatively rich. Therefore, knowledge exchange and sharing are realized through big data technology to maximize the total amount of knowledge of different groups. In addition, tacit knowledge in military nuclear safety is often abstract, which is difficult to exchange and share knowledge.

However, the common problems of tacit knowledge can be solved to some extent through big data technology mining and knowledge discovery.

Experience feedback can accelerate the exchange and sharing of nuclear safety knowledge. The Information Technology Center of CGNPC Group has developed the Experience Feedback System (EFS), which enables all employees of nuclear power to report any detected event conveniently and timely, regardless of their posts, and accelerate the tracking of event status and action improvement. Through this system, relevant experts can also conduct real-time communication and discussion, so as to realize rapid feedback of experience and sharing of expert wisdom knowledge.

3.4 Improvement of Military Nuclear Safety Management Means Based on Big Data

Through the big data knowledge sharing platform, the system integration of explicit knowledge and the mining and sharing of tacit knowledge are realized. The purpose is to enable military nuclear safety managers and participants in key nuclear related positions to break the time and space constraints, broaden the access to knowledge, and improve and expand nuclear safety management means. First, for the construction of nuclear safety culture, big data technology can quickly share concepts, cases and experiences related to nuclear safety in the organization. Secondly, due to the small number of personnel in military nuclear safety related posts and rapid flow, the risk of loss of key knowledge has been reduced to some extent through the development, storage and application of knowledge based on big data. When an employee in a key position leaves or retires, his key knowledge, including tacit knowledge, is saved through big data technology, providing a learning path for new recruits, thus reducing the dependence of knowledge inheritance on people. Thirdly, through the mining of big data association relationship, we can find the defects of nuclear safety management means and provide support for the improvement of nuclear safety supervision means. In addition, it provides a powerful means for personnel training and related scientific research in key nuclear related posts.

3.5 Evaluation and Feedback of Military Nuclear Safety Knowledge Management Based on Big Data

After completing the mining and integration of military nuclear safety management knowledge through big data technology and applying it to the application, safeguard, review, supervision, training and other links of military nuclear facilities and nuclear equipment, how effective is the application, where needs to be improved and where needs to be improved, and needs to establish corresponding evaluation and feedback mechanisms. These feedback information also provide data sources for military nuclear safety knowledge management, thus forming a virtuous circle in the knowledge management system.

The results of military nuclear safety knowledge management can be evaluated from multiple aspects. First, from the perspective of risk assessment of nuclear safety knowledge loss. Every year, the nuclear safety management authority organizes risk analysis on the loss of nuclear safety key knowledge from the aspects of personnel flow, knowledge acquisition, theme analysis, etc., to evaluate the effect of knowledge management, and provide feedback for data mining and knowledge discovery in the next year. Secondly, it can be evaluated from the use effect of grassroots troops, including the convenience, integrity and effectiveness of knowledge acquisition, to provide evaluation and feedback for the means of knowledge discovery and sharing. Thirdly, it can be assessed from the perspective of safety supervisors. In fact, nuclear safety knowledge management based on big data can provide decision support for regulators and assist in analyzing potential problems. Therefore, the evaluation feedback of supervisors can provide suggestions for improving data collection and knowledge mining.

4 Conclusion

Knowledge management and military nuclear safety culture have a natural connection. Combining the development of big data technology and knowledge management, build a military nuclear safety knowledge management model based on big data. Through the collection, mining and knowledge discovery of military nuclear facilities, nuclear equipment and other life-cycle data, it can effectively reduce the loss of nuclear safety professional knowledge, improve the level of nuclear safety management, and provide support for the training of nuclear safety related posts. At the same time, through the evaluation and feedback of military nuclear safety knowledge management based on big data, further promote the sustainable and sound development of nuclear safety knowledge management.

References

1. Zhou Hong-ying, Ye Xiang, Zhou Qing-yun, Exploration on establishment of nuclearpower knowledge management system. Progress Report on China Nuclear Science &Technology 2015(4): 339-344.
2. Shen Gang. Review on Nuclear Safety Activities of IAEA and Proposals for Enhancement of Cooperation between China and IAEA. Nuclear Safety. 2013 12(S1):88-94.
3. INIS and Technology Knowledge Preservation, R.Workman, Nuclear Sciences and Technology Services, British Nuclear Fuels pls.
4. Jing Ma. Application Research of Knowledge Management in the Nuclear Power Engineering Project Management Company. Shanghai Jiaotong University. 2013.
5. Gerald Onwujekwe, Kweku-Muata Osei-Bryson, Nnatubemugo Ngwum. A Framework for Capturing and Analyzing Unstructured and Semi-Structured Data for a Knowledge Management System. Computer Science & Information Technology. 2020(9).
6. Goonetillake Jeevani, Hettiarachchi Achini, Walisadeera Anusha Indika. A hybrid approach towards optimisation of data and knowledge management through cooperation of database and ontology. International journal of knowledge management studies. 2021(3): 243-267.

7. Mohamed Saifeddine Hadj Sassi, Lamia Chaari Fourati, Manel Zekri, et al. Knowledge Management Process for Air Quality Systems based on Data Warehouse Specification. Procedia Computer Science. 2021(192): 29-38.
8. Guo Yajun, Yuan Yiming, Yang Zhishun. Research on University Teaching Knowledge Management Mode Based on Big Data. Journal of Modern Information. 2021, 2021(10):101-108.
9. R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
10. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
11. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.