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To cite this article: Ning Zhou *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **643** 012141

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Construction of risk diagnosis mode database for South to North Water Transfer Project

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Abstract. There are complex and diverse engineering structures in the Middle Route Project of South to North Water Transfer. In order to ensure the normal operation of the project during the operation period. By analysing and summarizing the possible dangerous situations, it can effectively improve the emergency response ability of relevant management departments. In this paper, typical structures and risk databases are built based on the method of entity relationship graph. Using the related factors in the history risk databases, the engineering factors, environmental factors and human factors are sorted out to subdivide the entities. The relationship between risk factors and typical structures is carried out by risk codes, so as to build a complete engineering risk database.

1. Introduction

The Middle Route Project of South to North water transfer is a large-scale water diversion project, which has the characters of cross basin, large flow and long-distance [1]. It is an important strategic infrastructure to alleviate the serious shortage of water resources in North China, optimize the allocation of water resources and improve the ecological environment.

The purpose of risk identification and diagnose of the middle route project is to comprehensively and systematically analyse the possible engineering risks of the main river of the first phase of the middle line project, identify and sort out the risk factors, analyse the possibility of various events affecting the safe operation of the project, and the possible casualties, economic losses, social and environmental impacts caused by the events, and propose elimination, prevention and avoidance Suggestions on engineering and non-engineering measures for risk reduction provide technical support for formulating operation scheduling plan and risk disposal management measures to deal with various event conditions, improving project operation and maintenance system, optimizing operation scheduling system and reasonably allocating corresponding resources.

Understanding and mastering the causes, influence scope and influence degree of the risk of the middle line project is of great significance to enhance the awareness of prevention, reduce the probability and influence degree of risk events, improve the safety and reliability of the project, guarantee the safety of the project operation.

At present, some domestic units have carried out some research work on risk analysis and risk management of the Middle Route Project of South to North Water Transfer, and have achieved some constructive results, but there is still a lack of comprehensive and systematic research. Therefore, on the basis of the existing research results, this paper establishes a set of datasets for risk identification and diagnosis, which is very necessary for the identification and diagnosis of the risk situation of the south to North Water Transfer Project [2].



2. Method

Entity relationship diagram, also known as ERD or ER diagram [3], is mainly used for database design. An ER diagram generally contains three kinds of interrelated information: entity (data object), attribute (data object) and the relationship between data. A good ER diagram can clearly reflect the correlation between entities and related events. Based on the complex risk situation of the middle route of the South to North Water Diversion Project, this paper will use this method to build entity relationship diagram and build risk model database. The purpose of the design is to make clear the relationship between the dangerous situation and the structures.

3. Construction of ER diagram

3.1. Core entities

The core entities of the middle route of South to North Water Transfer Project are typical structures and types of risk situations. The relationship between the typical structures and the types of dangerous situations is determined by the types of their attribute projects. Among them, typical structures are mainly based on the existing engineering information of the central line, of which the attributes include: structure code, structure management, structure name, structure type, starting point of structure, and ending point of structure; while the attributes of risk types are structure type, risk name and risk code. The two entities are related to each other depending on the structure type. According to the current engineering situation, the types are divided into seven types: inverted siphon, aqueduct, culvert, channel, tunnel, gate and other structures.

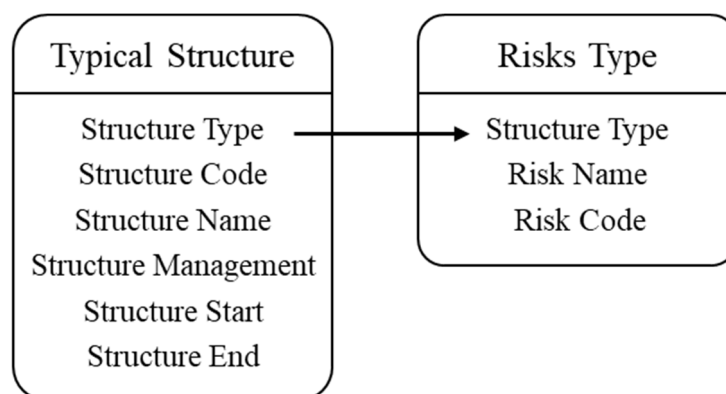


Figure 1. Two Core entities relationship diagram.

3.2. Related entities

After identifying the core entity of the risk model database of the Middle Route Project of South to North Water Transfer, this paper takes typical structures and risk types as the center entities, and then builds up a more detailed entity structure analysis. For typical structures, the number and types of main structures in the Middle Route Project of South to North Water Diversion Project are numerous, and they change with different natural environment. From the perspective of practicability of risk assessment and convenience of unit evaluation at different levels, typical structures are divided into three levels, which are represented by letters. Two entities are designed as one- and two-level code and three level code.

The related risk events can be sorted out from the historical recorded and predicted dangerous situations, so the entity of historical risks are constructed, in which the attributes include structure name, structure type, occurrence time, risk level and risk type. The related entity relationships of typical structures are shown in Figure 2.

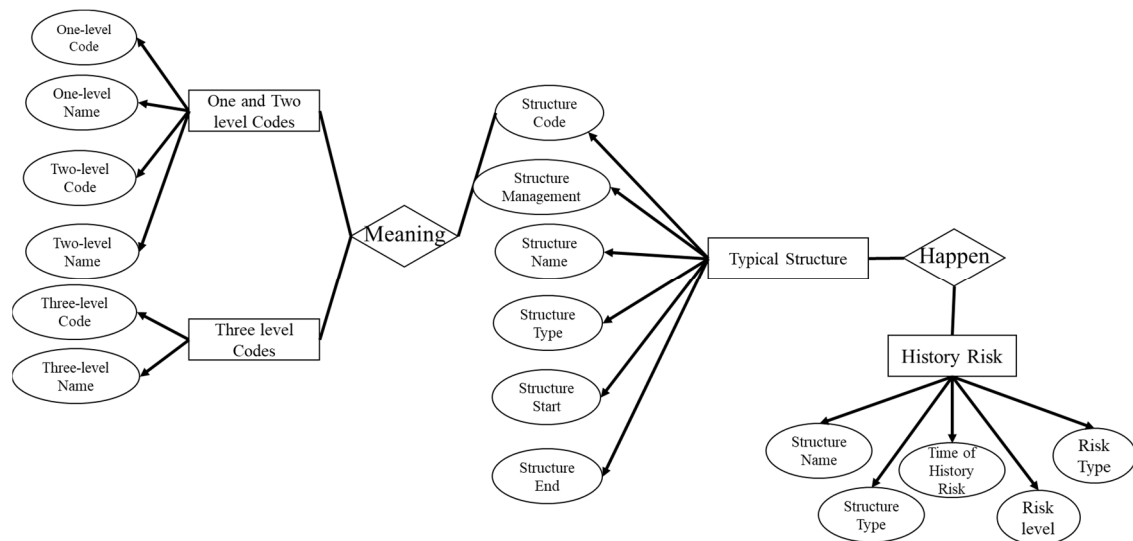


Figure 2. Typical Structure entities relationship diagram.

The types of risks are divided into related entities, including risk factors, risks names and factors, and modes. Among them, risk factors will describe in detail the basic factors causing risks, and their attributes are risk code, structure type, factor type, factor name, unit, weight, factor level 1 condition, factor level 2 condition, factor level 3 condition and factor level 4 condition.

The attributes of risks and factors include the structure name, risk code and the number of risk factors. In addition, in order to clarify the risk trend of dangerous situations, a failure mode is established, including code number, damage risks and path level, so as to connect the relationship between the types of risks and risk factors (Fig. 3).

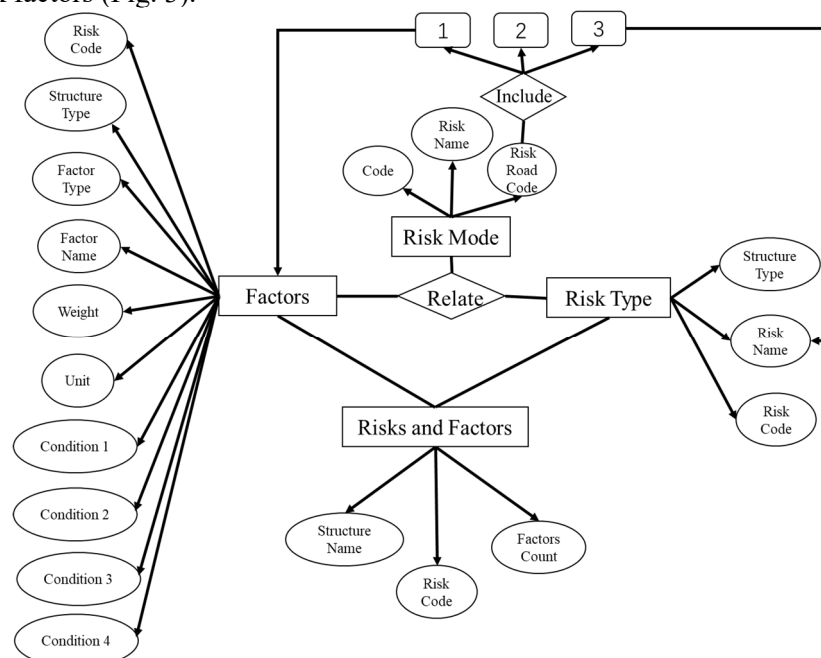


Figure 3. Risk Type entities relationship diagram.

3.3. Association and entity classification

From the above entity relationship diagrams, it is not difficult to find that there is a certain same attribute between the entities. The structure types in typical structures connect the historical dangerous situation

and the risk types. Through the historical inspection and related research, the historical situation types are summarized as: lining surface plate failure, landslide, anti-floating instability, anti-sliding instability, overtopping collapse, leakage damage and silting. Among the risk entities, there are three entities associated with risk factors, failure modes and risks and factors. The attributes of risk types connect all entities.

As described by the core entity, structures are mainly divided into seven types. The risk code is defined according to the description of the dangerous situations, and then the three entities are associated (Fig. 3). In the failure modes entity, the path level is mainly divided into 1, 2 and 3 levels. The level 1 is associated with the risk factors, and the 4 factor levels in the risk factors determine the 1-level risk event in the failure mode, while the 2-level path represents the intermediate risk path, and the 3-level path is connected with the risk events in the risk category, which is the final possible dangerous event caused by the risks.

3.4. Individual damage mode of typical structures

For the types of risks situations, the first category mainly includes leakage, instability, silting and overtopping, while the second category is the detailed description of risks determined by different structure types; Based on the related entity relationship of dangerous situation, the risk factors are described. The types of risk factors are mainly divided into environmental factors, engineering factors and human factors. According to the analysis of different structure types and engineering status, the engineering factors are divided into 31 factors; the environmental factors are divided into 16 factors; and the human factors are divided into 9 factors [4]. According to the different types of factors, the factor units can be divided into quantitative and qualitative. Therefore, the factor grade conditions 1-4 can be adjusted to different degrees [5-6]. In addition, the definition of weight is to use the relevant algorithm to diagnose the most likely dangerous events in the project. Risks with factors entity is related to risk factors and risk types. It mainly depends on the number of factors to determine how many factors are extracted from the risk factors for calculation, then diagnose the types of possible risk situations, then describe the dangerous situations through the risk codes.

From this entity association diagram, the relevant database can be established, as shown below (Fig. 4). Eight data can be built up into SQL server database, which include data of history risks, typical structures, the three-level code of structures code, the data of risks, the data of risk paths and the data of factors that affect risks. According to the characters of entity elements, this database defines each data type. Each ID can be described by integer and other elements can be defined by varchar string.

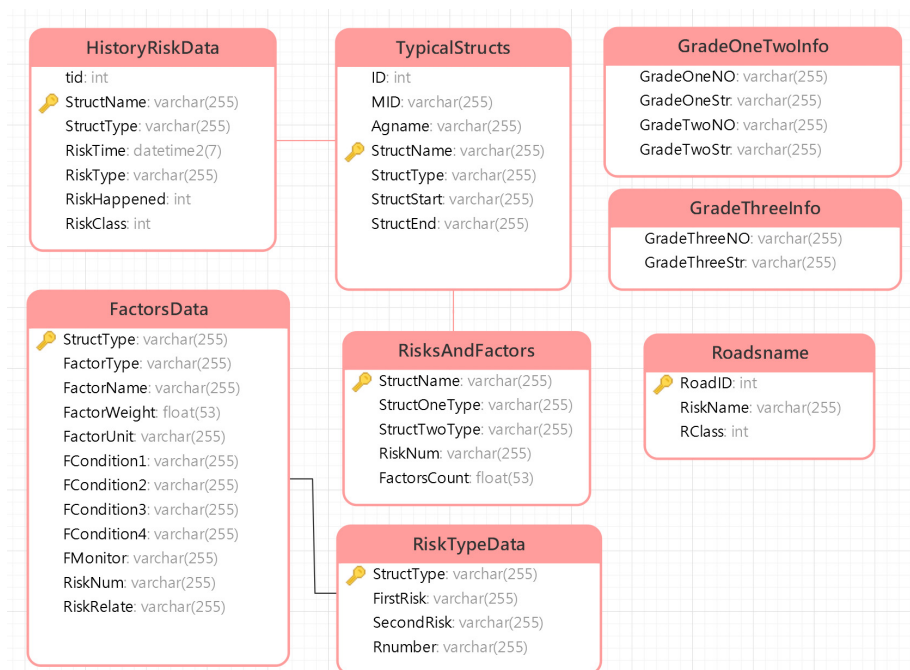


Figure 4. Establishing ER chart of Risks and Structures.

4. Conclusion

Based on the existing records of typical structures in the South to North Water Diversion Project and relevant research and analysis, this paper builds the entity relationship diagram of risk modes belonging to the middle line of South to North Water Transfer Project, and discusses from three aspects of design steps, ideas and methods. The risk events that may exist in complex water diversion projects can be summarized, which can more intuitively identify the risks of different structures, and provide technical support for the diagnosis of risk level of typical structures.

Acknowledgments

This paper was supported by the National Key Research and Development Program of China (Grants No. 2017YFC0405006, 2016YFC0401809), the National Natural Science Foundation of China (Grants No. 51579154), the Water Conservancy Science and Technology Project of Jiangsu Province (Grants No. 2017005).

References

- [1] Wang X.L. (2019) Study on the short board and Countermeasures of emergency management in the middle route of South to North Water Transfer Project. [J]. Research on water conservancy development, 19(04):25-31.
- [2] Liu H., Geng L.H., et al. (2011) Research on key technology in risk management during operation of South-to- North Water Diversion Project [M]. Science Press, Nanjing.
- [3] Deng C, Wang C.H. (2015) Fine design of E-R diagram [J]. Computer Education, 08:78-81.
- [4] Wang S. (2008) Construction and Evaluation of Emergency Management System for Large-scale Water Conservancy Project [D], Beijing.
- [5] Construction Administration Bureau of the middle route of South to North Water Diversion Project (2018), Comprehensive emergency plan for emergencies in the middle route of South to North Water Transfer Project[S]. Standards Press of China, Beijing.
- [6] Emergency plan for flood control of middle route of South to North Water Transfer Project (2018), Comprehensive emergency plan for emergencies in the middle route of South to North Water Transfer Project[S]. Standards Press of China, Beijing.