Research on Emergency Information Quality Assessment System in Big Data Environment: Postprint

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Abstract

[Purpose/Significance] Addressing the new challenges confronting emergency information quality management in the big data era, this paper proposes an emergency information quality assessment framework within the big data environment to facilitate the screening of high-quality emergency information. [Method/Process] Based on an analysis of the characteristics of emergency information under big data conditions and the requirements for high-quality emergency information in emergency management, we design and construct an emergency information quality assessment system for the big data environment; furthermore, we conduct a case study on domestic emergency information from the EPS database and EM-DAT emergency events database utilizing the cloud model. [Results/Conclusions] The assessment results demonstrate considerable consistency with actual conditions, indicating that this assessment system possesses certain utility in guiding emergency information quality assessment endeavors.

Full Text

Preamble

Research on Emergency Information Quality Evaluation System in Big Data Environment

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Abstract: [Purpose/Significance] This paper proposes an emergency information quality evaluation system in the big data environment to help screen high-quality emergency information, addressing new challenges faced by emergency information quality management in the current era of big data.

[Method/Process] Based on an analysis of the characteristics of emergency information in big data environments and the demand for high-quality emergency information in emergency management, we designed and constructed an emergency information quality evaluation system for big data environments. Furthermore, we conducted a case study using the cloud model to evaluate domestic emergency information from the EPS database and EM-DAT emergency events database. [Result/Conclusion] The evaluation results align well with actual conditions, demonstrating that the evaluation system has certain significance in guiding emergency information quality assessment work.

Keywords: big data; emergency information; information quality; evaluation system

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Emergency management concerns people's livelihood and well-being, and high-quality emergency information provides essential support for emergency management. However, the big data environment presents numerous challenges to emergency information quality: information noise creates interference in emergency information management, seriously affecting accuracy and scientific validity; multi-source heterogeneous data causes difficulties in management along with demands for dynamism and timeliness; and the explosive growth of information volume leads to redundancy and duplication. The advent of the big data era has transformed the information environment, which in turn imposes new requirements on emergency information quality, while emergency management activities also generate practical demands for information quality. Emergency information quality evaluation is critical for detecting whether quality standards are met. Its purpose is to eliminate low-quality, erroneous information, screen out high-quality information that meets emergency decision-making requirements, and provide reliable basis for further improvement and governance of emergency information quality. Properly screened and quality-enhanced emergency information can better support emergency management work.

1 Literature Review

In research related to information quality evaluation, Zha Xianjin et al. [1] highlighted the importance of information resource quality, elaborated on its connotation and extension, and constructed a 4-dimensional, 16-indicator information resource quality evaluation system. They also conducted comparative studies on qualitative, quantitative, and semi-quantitative methods for big data quality assessment. Song Weixiang et al. [2] noted that information quality indicators should include authority, originality, and appropriateness. Wang Xianya et al. [3] identified four categories of influences that information quality indicators exert on perceived usefulness and continuous search behavior. Wang Sufang et al. [4] evaluated the information sharing service quality of university libraries, constructing an evaluation index system comprising three dimensions—

"physical space," "information control," and "service effectiveness"—with 21 indicators.

Regarding emergency information quality research, most studies focus on specific indicators or emergency information service quality. Among them, Zhu Yiping et al. [5] proposed a data accuracy measurement framework for emergency information. Liu Chunnian et al. [6] evaluated emergency website information service quality and identified differences using emergency events as research objects. Yuan Weihai [7] pointed out that emergency information quality evaluation plays an important role in emergency information screening and constructed an emergency information quality evaluation index system. Liu Chunnian et al. [8] found that the lack of technology for evaluating the reliability of emergency product information is a limitation in seeking such information. Some scholars have explored emergency information in big data environments from different perspectives, with research primarily focusing on how to integrate and utilize it to support decision-making and achieve scientific management. Guo Lusheng et al. [9-10] explored development models and elements for emergency intelligence demand in big data environments and used enterprise architecture to plan emergency information resources, enabling sharing and system integration across different departments and systems. Guo Chunxia et al. [11] discussed the cultivation of emergency management talents to meet information management needs in the big data context. Li Lu [12] pointed out from multiple perspectives that multi-level and multi-faceted integration of emergency information should be achieved in big data environments.

Currently, theoretical research on emergency information quality evaluation is relatively weak both domestically and internationally, and the theoretical framework requires further improvement. Yuan Weihai [7] considers emergency information quality evaluation as a screening component in the emergency information management process and a key step for information filtering at various stages. H. Seppänen et al. [13] regard timeliness and accuracy as important reflections of emergency information quality. A. C. M. Oliveira et al. [14] proposed a scenario assessment method for evaluating emergency information quality, providing decision-makers with a model for understanding emergency situations under uncertain conditions. R. B. Street et al. [15] summarized major challenges in disaster information management, information quality control mechanisms, and the comprehensibility of emergency information, advocating for greater attention to the role of information quality in disaster prevention and response. Most evaluation methods follow those used for general information quality, and unified quality standards have yet to be established.

In summary, through analysis of existing research, we find that current emergency information quality studies concentrate on service quality or specific indicators, but deeper exploration of the essence of emergency information quality is needed. Most existing information quality evaluation index systems draw upon general information quality indicators, with insufficient in-depth analysis and application of emergency information characteristics. Meanwhile, in the big data era, the emergency information environment, characteristics, and management work are all undergoing changes. The complex dimensions, massive volume, and structural complexity exhibited by emergency information necessitate more in-depth research. Therefore, there is an urgent need to establish an emergency information quality evaluation index system that aligns with the characteristics of the big data environment.

Based on these findings, this paper proposes a 3-dimension, 8-indicator emergency information quality evaluation system for big data environments, grounded in relevant theories and practices combined with the characteristics and practical demands of emergency information in big data contexts. Subsequently, we select the representative EPS data platform and EM-DAT emergency events database, randomly choose nine types of domestic emergency information, and use the evaluation system and cloud model to conduct comparative assessments from different perspectives, providing evaluation basis for improving their emergency information quality.

2 Theoretical Elaboration and Practical Requirements for Emergency Information Quality Evaluation in Big Data Environment

2.1 Theoretical Interpretation of Emergency Information Quality Evaluation in Big Data Environment

2.1.1 Information Quality Evaluation Theory Information quality is a key component of information quality management, playing a crucial role in information resource quality control. Information quality evaluation standards serve as the "yardstick" for judging information quality. W. L. Yang et al. [16] proposed automatic source assessment methods from the perspectives of source comprehensiveness and stability. S. Madnick et al. [17] evaluated information from the angles of reproducibility and comprehensibility. J. M. Juran [18] argued that information quality evaluation standards should be formulated based on the degree to which they meet user information requirements. B. K. Kahn et al. [19] suggested that information quality evaluation standards should be defined from both product quality and service quality perspectives. Integrating these scholars' research, the definition of information quality standards should follow principles of accuracy, completeness, and systematic comprehensiveness, while considering both usage requirements and utility.

2.1.2 Connotation of Emergency Information Quality Since emergency information serves emergency work, its quality evaluation must fully consider its particularities. When evaluating emergency information quality, we should explore its connotation. Some scholars categorize emergency information into two types: narrowly defined as disaster information and resources, and broadly defined as all information related to emergency management [20]. Others consider emergency information as all information that supports emergency decision-making (such as disaster site information, plan information, and early warning information). Based on existing research and emergency management processes, this paper defines emergency information as information generated during emergency processes that is related to emergencies. Specifically, it can be divided into the following categories:

1. **Emergency Prevention and Preparation Stage**: Emergency education information (basic knowledge of self-rescue and mutual rescue), emergency plan information (emergency preparation, coordination and support (including materials, communications, shelters, etc.)), emergency policies and regulations (emergency norms, laws and regulations), and emergency expert information.

2. **Emergency Warning and Monitoring Stage**: Disaster warning and monitoring information, hazard risk information, emergency information reporting, and related early warning measures.

3. **Emergency Response and Rescue Stage**: News media reports, online public opinion, information about personnel, finances, and materials generated during emergency response, rescue and response measures, and shared information from emergency management processes.

4. **Recovery and Reconstruction Stage**: Disaster loss assessment, emergency event response reports, post-disaster government statements, and post-disaster reconstruction planning [21].

From the connotation of emergency information, we can summarize its resource characteristics: **Wide sources**. Emergency information originates from different entities across various emergency management stages, increasing evaluation difficulty. **Massive volume**. The wide source characteristic determines the risk of short-term information explosion, particularly prominent in the big data context. **Uncertainty**. The widespread use of Internet, mobile communications, and IoT technologies accelerates information dissemination, and the increased circulation speed inevitably introduces information noise interference, thereby increasing uncertainty. **Strong timeliness**. Information value decreases over time, especially for emergency information. Once the optimal transmission time is missed, both its value and usefulness will be significantly reduced [20].

2.1.3 Cloud Theory and Cloud Model In 1995, scholar Li Deyi first proposed cloud theory. To achieve the uncertain transformation between qualitative concepts expressed in natural language and quantitative data, scholars established the cloud model. A cloud consists of numerous cloud drops, which are mappings from qualitative concepts to quantitative values. Its overall shape depicts the qualitative concept. Cloud characteristics are described by three numerical values: expected value Ex, entropy En, and hyper-entropy He. Among them: expected value Ex best represents the qualitative concept; entropy En indicates the fuzziness degree of the qualitative concept—the larger the entropy, the fuzzier the concept; hyper-entropy He represents the dispersion degree of cloud drops—the larger the hyper-entropy, the "thicker" the cloud. Since its proposal, the cloud model has been successfully applied in natural language processing, data mining, decision analysis, and intelligent control.

In the real world, to make the nature of things more authentic and reliable, natural language description is needed. The emergency information evaluation system in big data environments inevitably involves various uncertainty factors. The best method for describing uncertainty is natural language. The cloud model can depict qualitative concepts through numerous quantitative concept values and their certainty degrees. Based on probability theory and fuzzy theory, the cloud model effectively combines the fuzziness and randomness of decision objects, achieving natural mapping between qualitative concepts and quantitative values while minimizing information loss during the mapping process [22].

2.2 Demand Analysis for Emergency Information Quality Evaluation in Big Data Environment

2.2.1 Analysis of Emergency Information Resource Environment and Characteristics in Big Data Environment Regarding the characteristics of emergency information in big data environments, the widespread application of IoT, Internet, and computing technologies in emergency management has broadened information sources. These sources continuously generate early warning information, geographic information, and interactive information, demonstrating characteristics of massive volume. Moreover, emergency information includes structured and unstructured data such as images, text, geographic locations, and online social public opinion, showing structural variety. Due to the suddenness of emergency events, the dynamic nature of disaster public opinion, and the application of network technologies, emergency information exhibits high velocity. Additionally, because of the large data volume and limited value density, emergency information shows value sparsity. Furthermore, given the critical position of emergency information in emergency management, there is a high demand for its authenticity. These characteristics align with the "4V" features of big data, requiring new approaches beyond traditional methods.

2.2.2 Requirements for Emergency Information Quality Evaluation in Big Data Environment The big data environment imposes new quality requirements on emergency information. As a crucial component of information quality management, big data emergency information quality evaluation holds an important position. Therefore, establishing and innovating theories, methods, tools, and standards for emergency information quality evaluation is imperative. Through quality evaluation and subsequent screening, emergency information quality can be improved both technically and managerially, thereby enhancing emergency information management capabilities and providing accurate, timely, and high-quality resources for emergency decision-making. The requirements for emergency information quality evaluation in big data environments are shown in Table 1 and Figure 1 [Figure 1: see original paper].

3 Emergency Information Quality Evaluation System in Big Data Environment

3.1 Preliminary Design of the Evaluation Index System

Currently, based on different understandings of information quality, experts and scholars have proposed various evaluation index systems [23-25]. However, due to the lack of solid information quality theory, research remains exploratory without a universally accepted evaluation system. Information resources in big data environments exhibit complex characteristics, and their quality is a multi-dimensional concept, making evaluation dimensions and indicators complex and diverse. Existing research shows that big data information quality analysis should include content analysis as well as utility, expression, and source analysis. The quality should be considered from both broad information dimensions and unique dimensions specific to big data characteristics, including both task-independent and task-dependent indicators. When selecting indicators, both general information properties and unique task-specific properties must be considered.

Reviewing domestic and international scholars' definitions of similar information quality dimensions reveals three main perspectives: **Content perspective**. Accuracy is pursued in big data environments, where information noise and complex, multi-format information make accuracy essential. Additionally, changing concepts and approaches mean people no longer pursue absolute precision but rather internal relationships, making error a quality factor. The timeliness pursuit and time-decaying value make timeliness a quality element. Big data's important manifestation is meeting different user needs in different contexts, making applicability another influencing factor. **Information user perspective**. Information must be credible for users to understand and utilize it effectively. Inconsistencies exist across emergency management stages, departments, databases, and within databases, causing quality problems. **Information value perspective**. Emergency information has general information properties, where institutional environment, accessibility, value, and content relevance are important quality elements.

Based on comparisons of big data quality evaluation indicators, information quality evaluation indicators, and emergency information quality indicators, and referencing expert research findings, we initially selected 12 indicators across 3 dimensions affecting emergency information quality in big data environments: content quality dimension includes accuracy, timeliness, applicability, and error; description quality dimension includes credibility, consistency, interpretability, and connectivity; constraint quality dimension includes accessibility, effectiveness, relevance, and institutional environment.

3.2 Expert Consultation

The classic Delphi method does not require preliminary indicator options in the initial stage but generates them through expert consultation. Based on previous research and practice analyzing factors affecting big data emergency information quality, we initially established indicator options. The Delphi method steps were as follows:

3.2.1 Expert Selection We identified 15 experts through multiple contacts, representing emergency education, research, and practice fields with professional knowledge and rich practical experience.

3.2.2 Questionnaire Design When selecting evaluation indicators, we conducted preliminary screening based on existing research and used questionnaires for expert assessment. The survey included research purpose, background, Delphi process introduction, and proposed evaluation indicators.

3.2.3 Expert Consultation Process 1. **First Round**: Experts scored each indicator's impact degree using a 1-5 Likert scale ("minimal," "moderate," "significant," "very significant," "extremely significant"). Results were aggregated and statistically analyzed. 2. **Second Round**: Based on first-round results, we reported the distribution of expert opinions to each expert, who then re-evaluated the indicators. In Delphi methods, expert opinions progress from inconsistency to consensus. In our study, opinions largely converged after the second round, so only two rounds were conducted. Coordination coefficients are shown in Table 2 . 3. **Third Round**: To determine indicator weights, we distributed questionnaires for experts to compare indicator importance, as shown in Table 3 .

3.2.4 Results Processing We calculated indicator weights based on expert consultation results. Since experts understood indicator content and importance during system construction, we used the Analytic Hierarchy Process (AHP) to determine weights. The importance comparisons are shown in Table 3 . Based on expert scores, we constructed judgment matrices, conducted consistency checks, and obtained final weights for primary and secondary indicators, as shown in Table 4 .

3.3 Finalization of the Evaluation Index System

Indicators with expert consensus scores $ $3 in the second round were selected. Through two rounds of consultation on 12 indicators, we eliminated error, credibility, relevance, and institutional environment indicators, retaining 8 indicators. In big data environments, the pursuit is not absolute precision but certain accuracy, so error is reflected in accuracy. Relevance is also reflected in consistency and connectivity, while institutional environment has minimal impact on emergency information quality. The final evaluation index system is shown in Figure 2 [Figure 2: see original paper].

3.3.1 Content Quality Dimension Information is the carrier of content, which is its most basic characteristic. Content quality includes accuracy, timeliness, and applicability: **Accuracy** is crucial for quality evaluation. In big data environments, information noise and low-value, erroneous, and interfering information challenge processing and decision-making. Higher accuracy means better reflection of reality. **Timeliness** reflects the effectiveness of information collection, transmission, decision-making, and release. Natural disasters and emergencies change rapidly, and big data's "one-second rule" reflects timeliness's impact on value, making it extremely important for decision-makers. **Applicability** reflects whether information meets user and decision-maker needs. Big data information quality also emphasizes meeting user requirements.

3.3.2 Description Quality Dimension Description quality manifests in semantic description states, including consistency, connectivity, and interpretability: **Consistency** includes logical consistency within databases and across different databases. **Connectivity** refers to whether presented information catalogs, classifications, and links are vertically and horizontally connectable across emergency departments and relevant. **Interpretability** indicates the degree to which emergency information facilitates decision-making and correct user understanding and usage.

3.3.3 Information Constraint Dimension When evaluating emergency information quality, besides content and description quality, general information quality constraints must be considered. These include: **Accessibility**—whether emergency information is easily obtainable by users and decision-makers, representing important utility. **Effectiveness**—the impact of emergency information on efficiency in emergency management activities is also an important quality metric.

3.4 Determination of Attribute Weights

Through the third round of expert consultation, indicator weights were determined using AHP, as experts already understood indicator content and importance. The importance comparison scale is shown in Table 3 . Based on expert scoring, judgment matrices were constructed and consistency-checked, yielding final weights for primary and secondary indicators shown in Table 4 .

4 Case Study on Emergency Information Quality Evaluation Using Cloud Model

Natural disasters and emergencies change instantaneously, and emergency information characteristics fully conform to big data's "4V" features, making it typical big data [28]. Therefore, big data technologies can be used for processing. Since the cloud theory was proposed in 1995, scholars have deeply applied it in information quality evaluation, natural language processing, data mining, and intelligent decision-making, with mature theory and applications. This paper attempts to introduce the cloud model into big data emergency information quality evaluation, fully considering its fuzziness and uncertainty to establish qualitative-quantitative transformation of evaluation factor impact intensity, providing a new option for assessment, management, and data mining.

4.1 Evaluation Process Design Based on Cloud Model

The specific evaluation process is shown in Figure 3 [Figure 3: see original paper]: (1) Establish evaluation indicator set; (2) Convert uncertain linguistic evaluation information to clouds, i.e., establish evaluation grade standards; (3) Introduce attribute weights; (4) Construct multi-level comprehensive clouds for each case from expert assessments; (5) Obtain evaluation results.

4.2 Sample Selection and Data Description

Sample selection is critical for research. When evaluating emergency information quality, principles of feasibility, scientificity, and representativeness should be followed. Based on investigation of emergency information databases, we selected the representative domestic EPS data platform and internationally comprehensive EM-DAT emergency events database. Both provide relatively objective and comprehensive emergency information with better openness than other databases, timely updates, and well-maintained data. Their comparability was also considered.

EPS is a professional data and information service provider covering economics, industry, agriculture, and science and technology. EM-DAT contains core data on various emergency events worldwide from 1900 to present, with objective and accurate collection of domestic emergency information. We randomly selected nine types of China-related emergency information from both databases: epidemic information, pest disasters, forest fires, droughts, earthquakes, floods, landslides, storms, and traffic accidents.

4.3 Implementation of Emergency Information Quality Evaluation

When evaluating the two databases, we again invited the previous 15 experts from emergency research and management departments to score the nine types of Chinese emergency information. Due to different research backgrounds and practical experiences, expert scoring has subjective characteristics with fuzzy results. Additionally, scoring in the same environment has certain randomness, making the cloud model suitable for evaluation. The survey included eight indicators. Experts accessed the databases, reviewed relevant materials, and evaluated each indicator, recording scores and matrices. Five evaluation grades were used: {very poor, poor, medium, good, very good}, i.e., S = {s-2 = "very poor", s-1 = "poor", s0 = "medium", s+1 = "good", s+2 = "very good"}.

4.3.1 Evaluation Indicator Set Assume S represents the target level—comprehensive quality of emergency information quality evaluation in big data environments. C represents the three quality dimensions: C = {C1, C2, …, Cm}, meaning information content quality, information description quality, and information constraint quality. Cij represents the secondary indicator set of Ci: Ci = {Ci1, Ci2, …, Cij}, where m = 1, 2, 3 represents three primary indicators, and Cij represents the j-th secondary indicator under the i-th primary indicator.

4.3.2 Converting Uncertain Linguistic Information to Clouds Using the golden section method, we converted expert comment sets to numerical features (z-2, …, z+2) [29]. Assuming the valid domain is [xmin, xmax] = [0, 100] and He0 = 0.1, the five clouds are: Z-2(0, 10.31, 0.26), Z-1(30.9, 6.37, 0.16), Z0(50, 3.93, 0.1), Z+1(69.1, 3.93, 0.16), Z+2(100, 10.31, 0.26). Using these numerical features as evaluation grade standard clouds yields Figure 4 [Figure 4: see original paper].

4.3.3 Introducing Attribute Weights Primary indicator weights: wi = (0.4126, 0.2599, 0.3275); Secondary indicator weights: wij = (0.1702, 0.1351, 0.1072, 0.1040, 0.0520, 0.1039, 0.1638, 0.1638).

4.3.4 Constructing Multi-level Comprehensive Clouds Based on average scores from 15 experts for the nine emergency information types in both databases, we obtained evaluation score matrices for each indicator. Using the backward cloud generator algorithm [30], we calculated cloud model numerical features Ci (Exi, Enj, Hei) for each indicator. The primary indicator results for databases A and B are shown in Table 5 , and secondary indicator results in Table 6 .

4.3.5 Comprehensive Evaluation Results Through weighted arithmetic averaging of the eight indicators using the cloud model, we obtained overall evaluation results: Cwaaa = (77.5012, 5.8962, 2.1535) for database A and Cwaab = (80.1247, 6.5228, 2.4506) for database B. Fitting these comprehensive indices with the evaluation grade standard cloud droplet diagram yields the comparison between databases A, B and the standard model (Figure 5 [Figure 5: see original paper]).

4.4 Evaluation Results Analysis

1. **Overall Quality**: The comprehensive evaluation indices show that both databases' emergency information quality falls between "good" and "very good," leaning toward "good" (69.1 < A = 77.5012 < B = 80.1247 < 100). Database B's quality is slightly better than database A's.
2. **Primary Indicator Analysis**: Database A is slightly inferior to B in content quality, description quality, and constraint quality. However, in description quality, while A's expected value Ex is slightly lower than B's, its entropy En and hyper-entropy He are better, indicating less variation in description quality across different emergency information types in A compared to B's more significant variations. In information constraint dimension, B outperforms A but also shows uneven quality across different information types.

3. **Secondary Indicator Comparison**: Database A shows better consistency and connectivity than B, but B excels in timeliness, applicability, and effectiveness. In accessibility and interpretability, A only serves research and government institutions requiring registration, while B, as a comprehensive national statistical information database, serves broader audiences with better user understanding.

4.5 Comparison with Reality

Without established database rating standards, we validated results by comparing both databases against "National Data" (http://data.stats.gov.cn/) across eight indicators. In accuracy, EPS database aligns with National Data, while EM-DAT has missing information (e.g., earthquake observation points, post-disaster reconstruction expenditures) and some unverifiable data. In timeliness, EM-DAT's earthquake and storm information is more timely than EPS, while EPS's other categories are more timely. In applicability, EPS's aggregated national departmental data has clear purpose and guidance for emergency work, while EM-DAT's data from foreign research institutions is more for research purposes, making it less applicable. In consistency and connectivity, EM-DAT's standards, structures, data items, and numbering are more complete and consistent since its establishment in 1988, while EPS (established 2005) has deficiencies. In interpretability and accessibility, EPS serves domestic institutions and residents better than EM-DAT's focus on researchers and foreign institutions. Thus, evaluation results align well with reality.

5 Conclusion and Outlook

This study examines the big data environment for emergency information quality, analyzes emergency management's evaluation needs for quality improvement, and provides demand analysis for subsequent system construction. Based on theoretical foundations and practical needs, we constructed a big data emergency information quality evaluation system using the Delphi method and assigned weights using AHP. The system effectively reflects big data environment requirements and comprehensively captures emergency information quality characteristics, providing guidance for evaluation work. We then applied this system with cloud model evaluation to assess EPS and EM-DAT databases, comparing results with reality to validate reasonableness.

Limitations: Emergency information quality measurement standards have subjective elements, making automatic evaluation difficult. Information sources are too broad, with some difficult to access, hindering metadata evaluation. Future research should strengthen quality standard construction and standardize metadata management through measures like constructing key business metadata, keeping pace with big data metadata technologies, and connecting business data with metadata to enable data tracking and updating emergency management department metadata.

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Abstract: [Purpose/significance] This paper proposes an emergency information quality evaluation system in the big data environment to help screen out high-quality emergency information in view of the new challenges faced by emergency information quality management in the current big data era. [Method/process] Based on the characteristics of emergency information in big data environment and the demand analysis for high-quality emergency information in emergency management, an emergency information quality evaluation system in big data environment was designed and constructed. Furthermore, the cloud model was used to evaluate the domestic emergency information in EPS database and EM-DAT emergency database. [Result/conclusion] The evaluation results are in good agreement with the actual situation, which indicates that the evaluation system has certain significance for guiding the quality evaluation of emergency information.

Keywords: big data; emergency information; information quality; evaluation system

Note: Figure translations are in progress. See original paper for figures.