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T Application of MES System in the Safety Management of Offshore Oil and Gas Fields

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Abstract: In order to solve the problem of data island in the safety management of offshore oil and gas fields, take full advantage of data for subsequent analysis and development, and support production safety management of oil and gas fields, the MES, which is maturely applied in manufacturing and downstream production of CNOOC (China National Offshore Oil Corporation), is introduced by the petroleum administration at the eastern South China sea. The system adopts the real-time database and relational database to collect the scattered structured data, such as evidence information of offshore oil and gas production facilities personnel, on-site hidden danger information and incident investigation report. Then a unified secure data center platform is established for every operating area and production site, and the critical safety data of production sites can be centrally managed. This system has the functions of lawful real-time supervision of personnel qualification, online supervision and trend analysis of hidden dangers, and centralized management and sharing of incident investigation report. By applying the MES system in security management, the process of safety service becomes standardized and modularized, the management process becomes normalized, and the efficiency and effect of overall management is improved.

Keywords: Certificate management, hidden hanger management, MES system, accident management.

1 Introduction

Due to the particularity of the petroleum and petrochemical industry, many kind s of safety risks exist. Thus, we must pay attention to the establishment of safety management system [Chao, Cannan and Hong (2009)]. Especially, the safety risk degree of offshore oil companies is higher, because the harsh natural environment of production sites, difficulties in rescue on land, high risks in shipping and aircraft transportation, concentration of personnel in small space, and improvement of environmental protection standards. Also, the outsourced multimedia data and its applications may reveal the data owner's private information because the data owners lose the control of their data.

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Recently, this thought has aroused new research interest on privacy-preserving reversible data hiding over outsourced multimedia data [Xiong and Shi (2018)]. In the era of big data, the conflict between data mining and data privacy protection is increasing day by day. Traditional information security focuses on protecting the security of attribute values without semantic association. The data privacy of big data is mainly reflected in the effective use of data without exposing the user's sensitive information. However, most searchable encryption schemes do not consider search result diversification, resulting in information redundancy [Liu, Peng and Wang (2018)]. Considering the semantic association, reasonable security access for privacy protect is required [Wang, Wang, Guo et al. (2018)]. CNOOC has established a relatively complete and advanced safety management system and many achievements have been obtained. However, there are still some problems in the process of establishing and implementing safety management, such as professional systems in production facilities, operating region, the company level system are various, the lack of unified information security management [Zhao, Jing and Zhang (2016)], poor compatibility of information resources, the original information collection consumes a lot of time and energy, low efficiency of management, an integrated business management system is needed, and difficulties in forms statistics and decision analysis.

Therefore, in order to solve the above problems, the MES (Manufacturing Execution System) [Wang, Zhang and Chen (2010)], which is maturely applied in manufacturing and downstream production of CNOOC, is introduced by the shenzhen branch of CNOOC co. LTD. and the system has been worked well.

The MES originated in the manufacturing industry and it is widely used in product manufacturing enterprises. The MES is an application system of information integrated management in manufacturing and production of enterprises, which is dominated by real-time collaboration thought [Grudin (1994)], focuses on the execution of production plan and dynamic workshop scheduling, and integrates lean production concepts and methods, constraint theory, enterprise resource optimization theory, supply chain management, outsourcing management, human resource management, business management and other advanced management concepts, and fully absorbs the experience, lessons and research achievements of informatization construction of the domestic and foreign enterprises in the past decades, especially the discrete manufacturing enterprises [Li, Wu and Yang (2015)].

SMES have been developed on the basis of MES [Yang (2011)], which mainly serves small and medium-sized enterprises. The MES solution focuses on enterprise customers with the requirement of manufacturing information construction, and it is one of the core foundations for manufacturing enterprises to realize total advanced management. At present, it has a very mature application in the downstream production enterprises of CNOOC.

Based on the MES of shenzhen branch, with the help of advanced information management technology, expert system knowledge [Yang (2011)] and the application of complex event processing technology in enterprise data processing [Wang (2012)], a branch unified online security management platform was established. Then, the problem of using multiple systems for field personnel is solved, the on-line collection, storage, management and use of all related safety record data of offshore oil and gas fields are realized. Centralized data can be interacted and shared. The patterns and processes of existing security business management are optimized and standardized. The immediacy,

continuity and standardization of security management is achieved. Therefore, the system provides strong support for daily safety management, safety optimization and safety decision-making.

2 System design

In Fig. 1, the system is designed with the help of the application of hierarchical computing in computer software development [Meng (2017)]. Through manual filling, template import and interface, the basic data is collected. Then the applications of various business functions are carried out based on the basic data. After the approval of each business data, the data and related applications are presented, and interfaces are provided to other systems for data interaction.

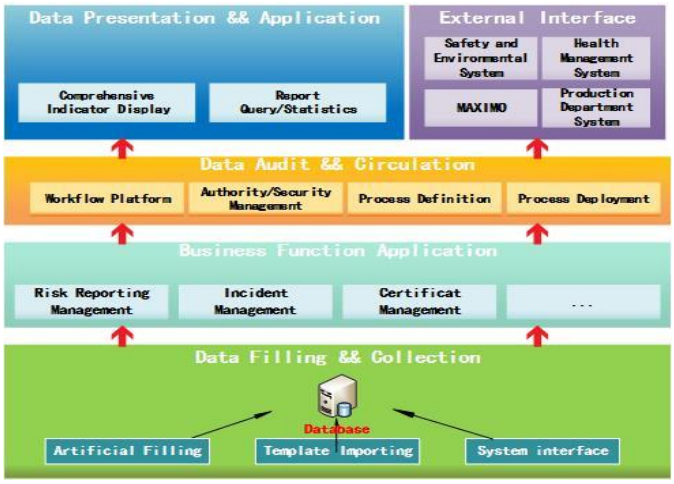

Figure 1: The framework of system functional

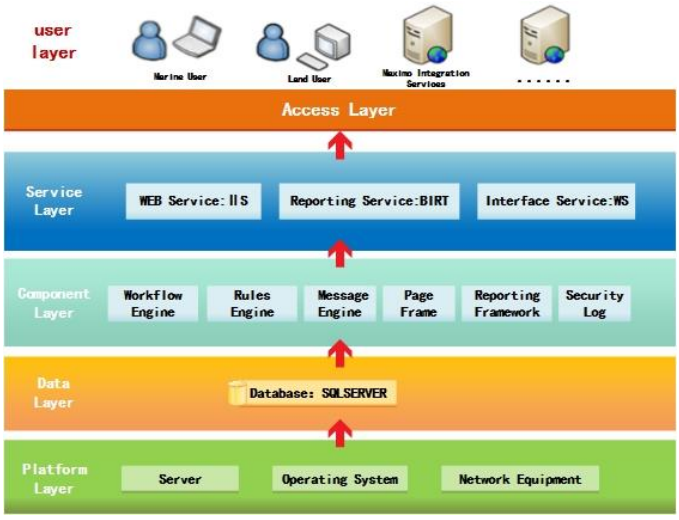

Figure 2: The framework of system functional

- Podium layer

  The podium layer mainly includes the server, operating system and network equipment of the system, to provide computing, storage and communication resources for the upper service.
- Data layer

  The data layer mainly is the data storage service. Based on the mainstream SQLServer in the industry [Yan and Zhang (2009)], the data storage service management is implemented.
- Component layer

  The component layer is composed of various service components, and is responsible for the customization and implementation of each functional business scenario. The various services of the component layer will ask the corresponding component to complete the corresponding work after receiving the request.
- Service layer

  The service layer is responsible for providing external data access services, which includes WEB services [Springer (2009)], reporting services, interface services, to realize the interaction between users or external systems and the system.
- Client layer

  The client layer includes offshore platform users, land related users and systems with data interaction in security aspects.

3 System functions and applications

Since the application of the security information platform MES of the petroleum administration at the eastern South China Sea in May 2017, all functions of the system have been well applied. The automation function of safety management assistance is fully represented. Therefore, the workload of field staffs is reduced. The work efficiency is improved, and the field production data becomes centralization, which is helpful for the management users to check the trend analysis of vital data. Thus, the system is highly recognized by field users.

The main modules in MES of security information platform include certificate management system, hidden danger management system and accident management system. The state, trend and dynamics of each link of safety management are reflected intuitively through statistical analysis and traceability of various safety data. Various reports and graphics can be generated according to requirement, which can provide scientific basis for safety management decision-making.

3.1 Certificate management

The functions of certificate management include the online centralized query and tracking management of personnel certificate information. Centralized on-line storage of all personnel certificate data, tracking and reminding the expiration time of the certificate, and multidimensional query and statistics of personnel certificate can be achieved.

- Training matrix

  The training matrix is provided for all users to view the training matrix data information online and download the matrix file.

- Statutory training

  The unified online tracking management of statutory certificates is realized. Users can import and export the personnel certificate information in batches through the template, and the statutory training certificate can be expired reminder. Statutory training and skills improvement certificate can be converted.

  The statutory training data list will have data expiration and close to expiration warnings. The blue data means the certificate will expire within one year, and there will be blue reminder all the time. The red data represents the certificate has expired, and there will be a red reminder. The users will be notified by E-mail one month before expiration of certificates.
- Skill improvement

  The unified online tracking management of skills improvement certificate can be achieved. Users can import and export the certificate information of personnel skills improvement in batches through the template. Skills improvement and statutory training certificates can be converted.

3.2 Hidden danger management

The hidden danger report online filling, query display, and statistical analysis function can be realized. The on-site safety supervision will report the hidden danger report data online and submit the process approval. After the approval, the report data can be statistically analyzed, and the headquarters ledger template can be exported.

All personnel at the production site can access the system to input hidden dangers through the public account, and fill out and submit the hidden danger data. After receiving the hidden danger data, the safety supervision will fill in the relevant data, submit it for approval and push it to land.

The hidden danger process is firstly confirmed by the on-site safety supervision, and the approval is sent to the facility director. If the hidden danger assessment value is less than 5, the process is circulated to the safety supervision and ends. If the hidden danger assessment value is more than or equal to 5, the supervision needs to send it to the land production manager. The manager approves and sends it to the safety manager. If the safety manager approves that the maintenance participation is required, it will be sent to the drill repairer project manager or maintenance manager as needed. If no maintenance is required, the process will be circulated to the safety supervision and end. When the approval of each node is returned, all of them are returned to the starting point of safety supervision. At the same time, when the approval of each process node is sent, the system must send an E-mail to the relevant personnel for reminding.

Table query of hidden danger report: realize multidimensional data query and analysis statistics of hidden danger data, including hidden danger overview statistics, hidden danger category statistics, hidden danger direct cause statistics, and hidden danger classification statistics.

3.3 Accident management

Accident investigation report online fill, query, and statistical analysis function. The accident investigation data is imported into the system through the template by the safety

supervision. Multiple rectifications can be initiated and distributed to the corresponding rectification person according to the investigation report of the same accident. After the rectification measures are filled in by the rectification person, they shall be sent to the director for unified review and closure, and the rectification situation can be regularly reminded by E-mail.

After the import is completed, the event can be rectified. The corrective measures can be filled in and the notification of rectification can be sent to the rectification person by E-mail. After the offline rectification is completed by rectifying person, the feedback will be sent to the safety manager. Then the safety manager records the rectification results. The rectification process will be initiated and the results will be sent to general manager for approval.

Query statistics of accident investigation charts. For all accident events imported into the system, the system can be used for statistics, analysis and automatic chart formation, which provide reference for safety management decisions.

4 Application effect

- Field data sharing

  The real-time data center of the field safety management process is established. It is realized that the centralized and unified management of safety management data. By taking full advantage of database technology, modern network technology and computer technology, information sharing is realized, and the office is truly connected to the production site.

  Based on the safety information management system, a unified safety data center platform is established for all operating areas and production sites. The safety data on site is concentrated, the tedious operations of manual and mail transmission data are eliminated, and site personnel productivity is released. At the same time, related data is recorded by means of manual input and import. The unified export of field safety data is realized to standardize the field safety management. The platform also provides data support for optimization decisions of safety management work on land and site, so that the users on land and at sea can centrally access the data which they care about. The data are clear and intuitive, which avoids the tedious operations to read emails and documents. The data management and demonstration are unified, and the management effect is improved.

- Simplify report submission

  In the past, all kinds of data were collected by field staffs who filled in relevant data, submitted and reported by E-mail, and gathered by special personnel on a regular basis. This way has not only heavy workload, but also lack of real-time. At present, trend analysis can be conducted by automatically summary of the system, so that the results are faster and more accurate. Safety managers at all levels can be liberated from tedious and repetitive routine work, and security personnel will mainly focus on on-site risk control. At the same time, the system provides data support for daily supervision of managers and work optimization.

- Assist safety decision

Real-time dynamic analysis of data of security management process and historical data storage are achieved. It comes true that the comprehensive dynamic visualization in the management process, such as real-time condition monitoring and trend analysis. Accurate real-time field data can be collected. These provide a basis for management to timely understand the dynamics of safety management, respond quickly to real production processes, and make trend analysis decisions on historical data.

- Standard management process

  Through the information management of the system, standardized and modularization of business processing, the management process become normalized, and the artificial errors of manual reports in the process of making and circulating are eliminated, and pursued ideal management results, so as to pursue ideal management results. At the same time, the responsibilities of each position are clarified, and the management mode is optimized. Internal communication is reduced, and the management is standardized and the process is institutionalized.

- Improve execution efficiency

  Through the implementation and application of the system, the work process can be reduced, the office efficiency of users can be improved, and the communication between staffs can be real-time and fast. The task transmission is efficient and clear, and the progress of tasks and work can be timely understood. Related reports can be generated automatically, which reduces the workload of personnel and improves the work efficiency.

5 Conclusion

Through the implementation and application of MES in safety management of offshore oil and gas fields, the whole process and omnibearing information management of production site safety can be achieved. A unified and secure online management platform is established, so that the safety data can be stored centrally and standardized. The data becomes shared and extracted, and can be queried and exported in real time. Through the certificate management system, lawful real-time supervision with the work permit is carried out. The information management of the system for hidden dangers, accidents and other safety problems has improved the ability to analyze the causes of hidden dangers in operating units. The basis for the work units to make targeted rectification measures is provided, and the management level of hidden danger of working units is improved. The application of MES system in security management makes the security business process standardized and modularized, standardizes the management process, and improves the overall efficiency and effect of management.

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