An Intelligent Site Environment Survey System Platform Based on ‘Internet + Database’

Yanli Zhi1*, Weili Xi1, Tao Bi1, Chao Li1

1Tianjin Eco-city Environmental Technology Co. Ltd., Tianjin, China
E-mail: 18902021697@189.cn

Abstract Intelligent environment survey system platform integrates Internet, database, geographic information system and other technologies, including PC side web page and mobile side APP. The platform is applied to the site environmental survey and monitoring practice, assisting the site environmental survey and monitoring work, solving the problems of site monitoring and survey data management difficulty, high cost, low efficiency, standardization of work procedures and content, low degree of automation, and improving the site survey work efficiency and quality.

1. Introduction
Since 2016, China has made great efforts to carry out soil pollution investigation, master soil environmental quality status, build soil environmental quality monitoring network, and improve the level of soil environmental information management. Under this background, site environmental investigation is carried out in large quantities. However, for the site environmental investigation and monitoring specific implementation institutions, especially the small and medium-sized front-line institutions, in the actual work is faced with many problems, such as the site information management scattered, site monitoring and reconnaissance data repeated record transfer, work procedures modular, low degree of automation. The study and construction of the site environmental survey data management system can effectively standardize the work procedures and improve work efficiency. Real-time management of site reconnaissance information and site monitoring data, integration of data time domain and spatial attributes, establishment of site database. The site environmental monitoring shall be incorporated into the management system, and the whole process quality control shall be carried out to make the data true and reliable.

Some countries in the world field survey work carried out relatively early, the EPA was established since 1987 pollution site technical support institutions, application development a lot of models and geographic spatial analysis toolkit, including field parameters to obtain equipment, technology, and percolation environment assessment tools, landscape forecasting tool, city life garbage decision support tools [1-4]; It also includes some site survey databases, risk assessment models, etc. The more typical ones are Scribe software and SADA model. The system design is more oriented to database development, collecting big data and building big systems. It is more focused on data display. The system is too large for small and medium-sized institutions engaged in front-line site investigation and monitoring. However, there is not enough attention paid to the specific basic work such as the real-time management of field data, monitoring work, especially the field work specification. Combined with the actual situation of site survey, the data information system for the application of small and
medium-sized grassroots departments was developed to realize the timely and effective management of site survey data.

2. Functional Requirements and Technical Approaches

2.1. Functional Requirements

(1) Management of site survey information: Including site survey and personnel interview of primary data, need to be filed immediately. Site photos, records and other work traces need to be properly kept.

(2) On-site sampling management: It can be seen from the analysis that on-site sampling is the biggest quality risk of site environmental investigation and monitoring work, and it is also the key link to standardize the work process and improve the efficiency of data management through the platform, and it will also have obvious benefits.

(3) Sample flow management: Sample quality management needs to run through the full life cycle of the sample. It will bring great convenience to track the sample flow and automatically generate relevant forms through the platform assisted management.

(4) On-site analysis management: Some indicators need to be analysed and tested on the sampling site. The site conditions are complex, and the analysis activities should meet the requirements of CMA (China Inspection Body and Laboratory Mandatory Approval) system. More importantly, caution should be taken.

(5) Project document management: The data collected by the project are of various types and contents, which require the platform to assist in collecting and archiving, facilitate access, and verify the completeness of the data.

2.2. Technical Approaches

(1) Database technology: Database is the carrier of information management system. Data editing, conversion, transmission, batch update and query are all based on database. The advanced database technology can realize the hierarchical and classified management of data, and the efficient and accurate reference and flow between different reports.

(2) Internet technology: Use Internet technology to complete the development of physical software and mobile devices. Real-time interaction between site survey data and data in the system can be realized through the mobile terminal, so that the working links and data such as the assignment of site monitoring task, sample collection and field analysis sample can be incorporated into the management system immediately, and the seamless connection between site work and laboratory/office can be realized.

(3) "3S" technology: Site investigation and monitoring involves a lot of field data. Through "3S" technology, spatial positioning can be realized, time and space attributes can be assigned to field data, accurate recording and marking of feature points and regional information in field reconnaissance and sampling work can be achieved, and the drawings can be displayed.

3. Design and Function Realization of the Platform

3.1. Platform Architecture and Module Design

According to the general idea of building the site investigation and monitoring information management system, several modules are designed. Combined with the work content and export demand, determine the basic functions of each module. See figure 1 for the basic architecture of the site investigation and monitoring information management system.

(1) Project Management Module

The overview module, information management system of data with project operation (new projects, open project, edit, delete, query and so on), task order (project site, sampling location, monitoring projects, quality control measures, implement standard limit/threshold, etc.), process management (field exploration and information collection, staff interviews, fixed-point of surveying
and mapping, a preliminary investigation, detailed investigation, report preparation, expert evaluation, modify, completion of projects, etc.), to remind management (project name, part name, implementation period, remind the completion date, etc.) and other basic functions.

(2) Site reconnaissance module
Manage site survey and hydrogeological survey, including data management, site survey information management, personnel interview information management, hydrogeological survey data management, etc. Instant input system should be provided for the survey information, personnel interview information, hydrogeological survey sampling information, site photos and other information acquired in the field survey process, and standardized forms can be generated as part of the final report preparation.

(3) Field sampling module
Manage environmental sample sampling on site, including sample collection, sample storage and transportation, sampling process quality control, etc. It has the functions of editing sampling tasks on the spot, recording sampling information (including quality control methods and indicators), and real-time storage of sampling photos, etc. For the indicators that need to be monitored on site, the monitoring data are recorded into the system immediately for preservation.

Figure 1. The basic architecture of the site investigation and monitoring information management system

(4) Sample management module
The main function of the sample management module is to generate the sample flow sheet, realize the traceability of the sample information, and connect with the analysis records to form the sample data chain to avoid sample information fracture or even loss.

(5) Form output module
Manage the output of the system, including the output of the records of each link and the output of the final site investigation monitoring report and evaluation report. There are many forms involved, such as project information table, field survey record, personnel interview record sheet, field drilling and well cleaning record, field soil and groundwater collection record, field and laboratory testing record, sample flow record, etc. Forms should be designed by specific staff with reference to relevant
specifications and combined with actual working conditions, and output different types of data and
information in multiple format files, which is conducive to the subsequent use of data and information.

(6) Data entry and analysis module

The analysis results of samples are imported in batches to make compound judgment of relevant
standards. Integrate environmental risk assessment, decision support and other professional formulas
or models to conduct in-depth analysis of data, and form a standard report.

(7) System auxiliary module

In addition to the above basic functional modules, there should be some auxiliary modules as the
necessary support of the system. The functions of auxiliary modules can be roughly divided into three
categories. The first is the editing and storage of basic information, such as information management
of customers, experts and subcontractors, rules and dictionaries, which are used to standardize specific
words and names and limit their affiliations. The other is to maintain the information referenced by
fields in the form, such as personnel information, indicator information, method information,
instrument information, etc., to facilitate the filling in and automatic generation of the form.

3.2. Software Design of the Platform

According to the above functional requirements, stability and security of the software, and combined
with the scale of software development, the following technologies are adopted for software design: (1)
ArcGIS Server is used to publish the base map and display and browse the data; (2) ArcSDE is used to
manage and organize map data; (3) Use Flex for rich client design; (4) Use Web Service technology
for background data management.

The software and hardware information of the platform is shown in table 1. The software is
developed by ASP.NET technology, the architecture is realized by B/S, the database is MS SQL
Server 2012, the Server operating system is Windows Server 2008, the PC operating system is
Windows 7 or Windows 10, and the mobile operating system is Android or IOS. The development of
mobile terminal APP is an important feature of this platform. Attention should be paid to the
convenience of operation and the stability of the system to meet the requirements of data input and
storage under complex and harsh conditions on the site.

| Table 1. Software and hardware information of PC and mobile terminal of platform. |
|----------------------------------------|----------|----------|
| PC                                     | mobile   |
| hardware environment                  |          |
| development tool                      | Desktop computer: 16 G RAM, 500 G hard disk, i7 CPU |
| operational procedure                 | Desktop or Laptop: 8 GB RAM, 250 GB hard disk, i5 CPU |
| operational procedure                 | Android Phone or Tablet: 4 GB RAM, 32 HDD, 4 CPU |
| software environment                  | Desktop Computer: Windows 7 or Windows 10 |
| development tool                      | C#, html, JavaScript |
| operational procedure                 | 915670 |
| programming language                  | Java, html, JavaScript |
| line source program                   | 79326 |

3.3. Data Input and Output of the Platform

3.3.1. Data Input. The data input of the platform includes input, import and upload, etc. First-hand
data collected and collected from outside the platform need to be manually input and transformed into
internal data of the platform. Specific operations are as follows: (1) The basic information of
the project shall be recorded in the general task list; (2) The data collected during site survey will be
manually uploaded to the platform to generate a data list; (3) Photos and information in field
investigation and personnel interview are mainly uploaded to the platform by mobile APP, and can be
edited again on PC; (4) The drilling, well washing and well construction information of
hydrogeological survey can be uploaded to the platform on the spot through the mobile APP, and then
edited on the PC; (5) On-site sampling plan: input the on-site sampling task list on PC, and edit it again with mobile APP according to the actual situation on site; (6) On-site sampling information and on-site monitoring information are mainly uploaded to the platform by mobile APP, and can be edited again on PC.

Data input is the starting point of data flow, and the platform constantly optimizes the data input mode to achieve friendly interface, intuitive and simple input, especially to optimize the mobile terminal input mode.

3.3.2. Data Flow. One of the requirements of the construction of the platform is to standardize the working process. The platform divides the prescribed working process into forms. By filling in the contents of the forms, it requires and urges the staff to complete the "prescribed actions", sets the permissions, and clarifies the rights and responsibilities of the staff. Establish a form review system, and determine responsibility through personnel signature.

The principle of platform design is that a data and information can only be input once, that is, from outside the platform to inside the platform. When the data within the platform is used again, it is automatically implemented by means of data reference. This greatly reduces the phenomenon of repeated data input, ensures the unity of data between forms, avoids the error of personnel input, and improves the work efficiency.

The main line of data is that the monitoring data and related information are collected at the sampling points according to the sample number as the index, and the point location information and related survey data are encapsulated in the project and archived according to the project number. The data flow is as follows: (1) the basic information of the project is quoted from the general task list and runs through the whole process; (2) The monitoring plan is transferred from the field task order to the field sampling order, which generates corresponding information according to the category, index and method input in the monitoring plan; (3) Drilling information (well location, number, etc.) is transferred from drilling record sheet to soil sampling record, and only soil sample information is required for soil sampling record; (4) Well construction information (well location, number, etc.) is transferred from well construction record to groundwater sampling record, and groundwater sampling record only needs to fill in groundwater sample information; (5) The sample number is generated in the sample record sheet, which is used as the unique identification of the sample, and the sampling information is transferred to the sample record sheet.

3.3.3. Data Output. The data output of the platform is currently divided into two categories:

(1) Record the form output
The output form of the platform design includes: personnel interview record (construction land), interview record of personnel (agricultural land), scene investigation record, borehole record in situ, well construction and cleanup records, ambient air sampling record, soil sampling record, groundwater sampling record, surface water sampling records, sediment sampling record, field monitoring record, sample handover record, and sample analysis record. The fields in the form are set according to relevant specifications, and the data are entered into the final form through input and circulation, etc. The form style is controlled file, and the output form is an important attachment of the site environment survey report. The platform designed the form packaging output function, the form belonging to the same project can output archiving with one key.

(2) Package output of acquired data
In addition to monitoring data, a large number of data were obtained during the site environment survey, such as regional standard data, site history and current situation data, site related enterprise data, etc. The platform designed the function of data download with one button, so that all data of the project can be downloaded with one button, and the corresponding file directory can be generated.

3.3.4. The Significance of Platform Building.

(1) Improve the quality of site investigation and monitoring
Site investigation and monitoring work is relatively complex, facing various problems, the site working conditions are poor. The development and application of the system platform can realize the real-time management of site reconnaissance information and site monitoring data, on-site revision of the investigation scheme, and timely access to accurate and effective information. At the same time, all links of the site environment monitoring work are incorporated into the management system to carry out the whole process of quality control, so that the data are true and reliable.

(2) Improve the efficiency of site investigation and monitoring and reduce the cost
In the current site survey and monitoring work, there are some problems, such as repeated transcribing of records and low degree of automation of work handover. The development and application of the system can realize information sharing without repeating records. Data automatic calculation, analysis, improve accuracy and efficiency; At the same time reduce manpower and material resources, reduce the cost of work.

(3) Promote the standardization of site investigation and monitoring work
At present, the link, content and data format of site investigation and monitoring work are not unified. The development and application of this system can effectively standardize work procedures, effectively guide the work, facilitate the work connection and improve compatibility, and then form a unified work mode and promote the standardization of the industry.

4. Conclusion
Built "Internet + database" and so on many technology integration platform for the intelligent environmental investigation system, integrated with a variety of technologies such as Internet, database, geographic information system, solved the venue site surveillance and reconnaissance data management is difficult, high cost and low efficiency, work procedures and contents of standardization, automation degree is low, improve the site survey work efficiency and work quality. The innovations of the platform are: (1) the efficient management of field data can be realized. The data acquired on the field can be input into the system instantly through the mobile terminal and can be interacted with the PC terminal to improve the field work efficiency; (2) systematically stipulates the work procedure and content of site investigation and monitoring, clarifies the relationship between the undertaking and circulation of each link of the work, and standardizes the work.

The current platform has been well applied in practical work. In the next step, we will continue to improve sample analysis, risk assessment, decision support and other modules, strengthen data analysis, characterization and display functions, and try to carry out multi-dimensional and big data information mining, with a view to providing greater help to the site environmental investigation.

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