Applications of GIS-based “one map” System in the Management of Certification Factory Inspection Process

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Abstract. Certification factory inspection is one of the most important processes of risk control and cost management of certification bodies. And the information technologies based on IOT and GIS can be adopted to build an information management system, which helps to improve the efficiency, reduce costs and increase the capability of risk management for certification. In this article, authors try to identify risks of factory inspection process using process method and explain how GIS-based “one map” system is developed to minimize risks. Important system functions of the automatic task-assignment, the optimal route-planning and the personnel positioning and tracking is also introduced.

1. Introduction
In recent years, the government has attached great importance to quality certification, and released a series of relevant guidance documents, including “Opinions on strengthening the construction of quality certification system and promoting total quality management”, “Guidance of CNCA on establishing and implementing the main responsibility system of certification bodies for compulsory product certification”, etc. These documents puts forward higher requirements for certification bodies in implementing the main responsibility, controlling the certification risk, strictly controlling the quality of certification and improving the service level. In order to meet these requirements, certification bodies must comprehensively improve their quality management ability by stepping up the construction of an all processes covered information management system, however the factory inspection process has always been considered as a difficulty and become a weak point of the information system [1].

Certification factory inspection is one of the most important processes of risk control and cost management of certification bodies, it requires the certification body to send audit teams to carry out audit activities for applicants nationwide, and the uncertainty of personnel activities may lead to management difficulty and cause unexpected risks. In order to identify all possible risk factors, every procedure of the factory inspection process was analyzed and checked against the requirements specified in necessary conformity assessment standard [2], certification schemes and procedure documents. The results of analysis were then used as inputs into the development of system functions, such as automatic task-assignment, optimal route-planning and personnel positioning and tracking, to minimize the identified risks and improve the certification conformity. Several other important aspects such as the cost reduction and efficiency improvement were concerned in the system as well.
2. Risk Identification of Factory Inspection Process

2.1. Representation of Factory Inspection Process

When managers of factory inspection receive work orders from previous process, the first step is to determine the audit time (person/day) based on the certification rules \[3\]. And then make an overall planning of all current tasks, taking into consideration of the information of application, factory locations, and qualifications of available auditors. At last the planned task combination packages will be sent to every appointed audit team, necessary information will be informed to relative applicants as well.

An audit team should be consisted of at least two auditors with a head and several members. After receiving the task package, the audit team needs to make detail plans including of the audit schedule and travel routes and should then perform audit tasks exactly in accordance with certification rules. A set of complete documentation, such as audit conclusion, required reports, necessary data and pictures shall be submitted to certification body punctually after audit finishing. The representation of the factory inspection process is shown in figure 1.

![Figure 1. Representation of factory inspection process.](image)

2.2. Risk Identification

2.2.1. Multi-task overall planning

According to the related standard, certification scheme and procedure documents, risks in the procedure of “Multi-task overall planning” are identified as follows:

- Making of unreasonable plans under complicated multi-task situations is possible for the less experienced managers, which may lead to an increase of travel and service costs;
- The appointment of audit teams and the assignment of tasks should be done fairly and impartially, and shouldn’t be interfered by personal relations or other subjective factors according to procedure documents. The break of this rule may present certification body with a risk to impartiality.
- All audit members should be qualified and authorized for the appointed audit task, a wrong appointment of auditors may cause non-conformity risks to certification body.

2.2.2. Task performing

According to the related standard, certification scheme and procedure documents, risks in the procedure of “task performing” are identified as follows:

- Audit team may make unreasonable travel plans owing to the incomplete access to traffic information and it will lead to an increase in travel costs;
- Falsifying audit report and providing fake information by audit team may represent certification body with a great risk to impartiality, and such problems can hardly be controlled and solved without specific technical methods;
- The audit team shall not change the audit time at will and finish the audit in advance according to procedure documents, however the behavior of auditors can be hardly controlled by the certification body, which will lead to a non-conformity risk;
- The data and evidence collected by audit team are not sufficient to support the audit conclusion, which will lead to a non-conformity risk;
- Emergency situations, such as unexpected changes of audit plan due to personnel or traffic problems may cause difficulty on resource administration and increase certification costs.

### 2.2.3. Follow-up activities

According to the related standard, certification scheme and procedure documents, risks in the procedure of “Follow-up activities” are identified as follows:

- The audit documentation, such as audit conclusion, required reports, necessary data and pictures are not sent to certification body according to the required time, resulting in the reduction of authentication efficiency;
- The submitted documentation is insufficient or incorrect, which will reduce the efficiency of certification.

All identified risks are summarized in table 1.

| Procedure | Procedure executor | Risks |
|-----------|--------------------|-------|
| Multi-task overall planning | manager | a) Making unreasonable plans;  
b) The appointment of audit teams and the assignment of tasks are done in an unfair way;  
c) Appointed auditors are not qualified or authorized for the specific audit task; |
| task performing | Audit team | d) Making unreasonable travel plans;  
e) Falsifying audit reports and providing fake information;  
f) The actual audit time is not accordance with certification rules;  
g) The collected data and evidence supporting audit conclusion is not sufficient according to certification rules;  
h) Emergency situations, such as unexpected changes of audit plan due to personnel or traffic problems; |
| Follow-up activities | Audit team | i) The audit documentation is not submitted according to required time;  
j) The submitted documentation is insufficient or incorrect. |

### 3. Application of “one map” System

#### 3.1. General Description of “one map” System

The “one map” system consists of the geographic information system (GIS) and the integrated task management system. The geographic information system is capable of displaying locations of manufacturer’s factories visually in the form of a map, and can achieve a real-time dynamic view of the people’s movement through positioning and tracking system. The integrated task management system has been built for the management of factory inspection process, which enables the operation of multi-task overall planning, auditors appointing and data uploading with the interaction between the PC end and smart phones. In addition, the function of automatic optimal route-planning has been
developed by connecting the system with third-party platforms that can provide comprehensive and accurate traffic information.

3.2. System Function Introduction: Automatic Task-assignment and Optimal Route-planning

To eliminate or minimize the identified risks a), b), c), d) in table 1, the system function of automatic task-assignment and optimal route-planning is listed as follows:

a) The “one map” system marks factory locations on the map and provides operators a clear display of selected tasks. It will make a task plan automatically by using the data of selected factory locations, inputted audit times and other application information. The operation interface is shown in figure 2;

b) A database with the information about qualifications and authorizations of all auditors is developed for accomplishing the function of automatic personnel-recommendation. The system can randomly screen auditors of the database and make a recommended list of appropriate auditors when a specific task is selected;

c) After receiving the task package, the auditors can obtain the factory locations visually in the form of a map and make a reasonable plan taking advantage of the optimal route-planning function. By connection with third-party platforms for comprehensive traffic information, the system can calculate and recommend the most efficient route-plan including of travel modes and time. The operation interface is shown in figure 3.

Figure 2. Operation interface of automatic task-assignment
3.3. System Function Introduction: Personnel Positioning and Tracking

To eliminate or minimize the identified risks e), f), g), h), i), j) in table 1, the system function of personnel positioning and tracking is listed as follows:

a) The movement and status of the audit team will be tracked and displayed in “one map” system. Figure 4 presents an overview of the positioning and tracking function[4];

b) On starting and finishing the audit task, the audit team should implement the sign-in and sign-off procedure within the area of 100-metres radius around the factory as shown in figure 5. The calculated audit time according to signing information will be automatically recorded and checked against the audit plan;

c) After sign-in, the audit team should take photos of the plant area and the photo selection from album is restricted, which provides evidence for the presence of audit teams;

d) The overall display of all current audit tasks facilitates the changes of audit teams under emergency situations. An overview of “one map” system is represented in figure 6;

e) The uploading of all the required information is standardized into the system, which prevents the shortage of the audit documentation. In addition the delay of data uploading will have a negative impact on the performance assessment of auditors.
4. Summary
In this article, authors try to identify risks of factory inspection process using process method and explain how GIS-based “one map” system is developed to eliminate or minimize these risks. The system provides the manager a clear overview of all audit tasks in a form of a map and achieved system functions of the automatic task-assignment, the optimal route-planning and the personnel positioning and tracking, which will significantly improve the conformity, reduce risks, increase efficiency and lower costs for certification. In addition, the development and application of the system can facilitate the construction of an all processes covered information management system and contribute to further improvement of management capability of certification body.

5. Reference
[1] Standard, S. R. P. S. "ISO/IEC 17065: 2013 Conformity assessment–Requirements for bodies certifying products, processes and services." Institute for Standardization of Serbia, Belgrade (2013).
[2] HU Qun-ming. Design and research of fire products certification and service platform[J]. Fire Science and Technology, 2019,38(05):727-729.
[3] Shuiping Zhang. Optimal planning algorithm of forest wetland tourism path based on GIS[J]. Journal of Discrete Mathematical Sciences and Cryptography, 2018, 21(2).

[4] Dapeng Li, Thomas J. Cova, Philip E. Dennison. Setting Wildfire Evacuation Triggers by Coupling Fire and Traffic Simulation Models: A Spatiotemporal GIS Approach[J]. Fire Technology, 2019, 55(2).