

International Symposium on Safety Science and Engineering in China, 2012
(ISSSE-2012)

Dynamic Security Decision-making Process

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Abstract

This paper aims to propose particular technologies that will help implement all dynamic safety decisions. Prior decision ensures optimization and effectiveness of security measures and prevents accidents from happening; matter decision offers the emergency measures against accident spread and extension; post decision ascertains the causes, provides relevant countermeasures and identifies responsibilities, which can help avoid similar accidents from happening again.

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Keywords: Safety decision, Prior decision, Matter decision, Post decision, Accident prevention

It is proved that safety decision fault is the fundamental reason. Taking the big blowout accident happening on Dec 23, 2003 as an instance, The main reason was identified as: after the blowout was out of control, in the face of whether ignition measures should be taken for choke line or not, policy-makers failed to make resolute decisions and clear instructions so that harmful gas containing high concentration hydrogen erupted, which made the accident more extensive and worse [1].

Most enterprises in our country grasp the concept of "Value production capacity, Despise personal safety", therefore, proper importance isn't attached to safety decision by these companies. There are two definitions of the so-called "safety decision". One is estimated roughly by the enterprises according to the annual security budget, accident type and the seriousness of accident aftermaths [2]. The other is that many firms analyze and cope with a variety of security problems appearing in enterprise production by their experience and perceptual knowledge. Under the guidance of experience and perception-orientated method and static individual safety decision, accidents still happen frequently [3]. Meanwhile, technology researches related to the safety decision goal, task, content and method around different phases of the accident control should be deepened and improved further. Consequently, this paper will do a research and discuss practical significance of dynamic security decision making techniques through researching and analyzing the whole accident dynamic control process.

1. Three stages of accident control

1.1. Three stages division

A complete accident control process, which is shown in fig. 1., includes three stages: before accident, accident process, after accident rescue. The target, content and means of safety decision in each stage is not the same, and one safety decision

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model can't completely accommodate to the whole accident control process. At any stage in the process of accident control, mutations are likely to emerge at any time, which requires companies to optimize decision on related technology and management measures and realize the dynamic process of decision-making in order that corporations are able to have prevention before accident, take relevant measures in accident process and implement responsibilities after accident rescue.

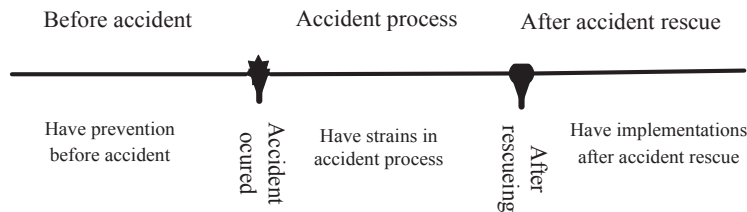


Fig. 1. Three phases of accident control

1.2. Three phases of the safety decision

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According to the process and stage of the object evolution, this paper divides safety decision into three different stages: prior decision, matter decision, post decision. Safety decision is designed to achieve the basic goal no accident and no loss. Each phase of safety decision has its own characteristics and requirements, including decision goal, task, content and method.

- Prior decision

This decision is accident prevention decision analysis before the accident and aims to realize the basic goal of "safe production, no accidents". Its main task is to identify all kinds of hazards related to the accident, choose the best control plan that means "minimum safety input, the maximum safe reliability" by making use of reasonable decision method and take control hazard in the appropriate range, which can make sure the system is under a safe environment. The core content of safety decision is to identify kinds, seriousness and key of the dangers and optimize control measures in advance. Prior decision, which involves the whole system and has certain constraints and influence to later matter decision and post decision, is the critical link of system plan or design.

- Matter decision

Matter decision means companies are able to provide emergency rescue measures timely and prevent the accident spread and extension when an accident happens, and aims to ensure personal safety and minimize losses. The main task is to apply scientific safety decision methods and decide the emergency rescue measures based on the favorable conditions and actual situation in the accident process. Decision content includes trapped people's safe escaping, the rescuers' safe work and accident enlargement avoidance. Rescue process of the same type accident may be different, therefore, it is difficult to implement the accident rescue and prevent accident expansion only by the experience.

We don't have enough time to go for safety decision when accidents really happen, so the specific operation of the matter decision should be finished before the accident. Matter decision is a series of safety decision before accident. If such similar accidents happen, computer emergency rescue information decision assistant system can help to realize safety decision.

- Post decision

Post decision deals with safe hazards effectively after the accident rescue and aims to eliminate the hidden trouble of such accidents and take control them from happening again. In addition, its main task is to verify the essence reason of accident, propose and implement reformation measures and supervise accident liability effectively. Post decision which is different from the next round of prior decision is not an end of accident control decision process, but the beginning of the next round of prior decision.

As stated previously, based on tasks, goals and contents of three stages of the accident control, feature list of various stages in decision-makings can be constructed, as shown in table1.

Table 1. The security decision-making features of each phase

Decision stages	Decision goals	Decision task	Decision contents
Prior decision	Accident prevention	Optimizing measures	Risk identification Risk analysis Technical measures Management measures Emergency plan
Matter decision	Preventing accident enlargement	Emergency rescue	Emergency preparation Emergency response Site recovery Reason check
Post decision	Avoiding accidents happening again	Implement rectification	Responsibility investigation Corrective measures Supervision implementation

2. Safety decision process

Safety decision is a process that people lay an action plan for safety goals and prepare for organizing and implementing this plan. Besides, it can also put forward, analyze and resolve problems. Safety decision process mainly includes five stages: propounding questions, confirming aims, structuring function, analyze, evaluate and verify scheme, as shown in fig. 2..

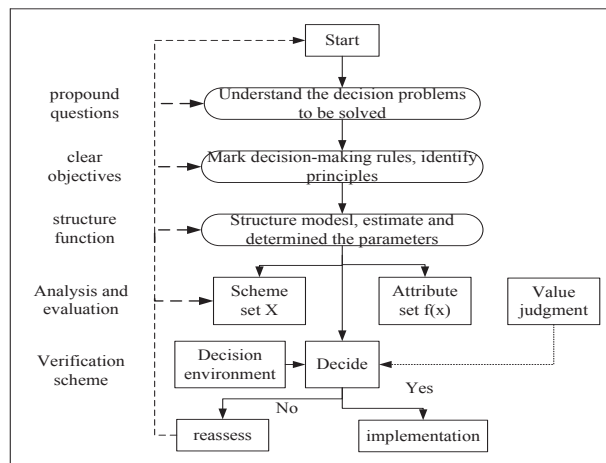


Fig. 2. Safety decision process

Propounding questions stage: Propounding question is the starting point of decision process. Based on the established decision purpose, companies collect and organize the related information actively, find out the gaps between them and confirm problems. The next level of standard can't coordinate with layer level standard absolutely, which is the principle of finding problems should be noted.

Confirming aims stages: Setting goals means decision makers work out a variety of ways and methods to solve problems on the basis of investigation and forecast in certain environment and choose several satisfactory decision-making plans carefully according to the standard of decision objective.

Structuring function stage: According to the decision goals, decision makers establish physical and mathematical models for every selecting decision-making plan get the solution of each model and evaluate these results in the end.

Analyzing and evaluating plans stages: First, analysts apply scientific analysis method to investigating and studying the rules, functions, the environment, costs and benefits of the system. Second, they collect, analyze and process relevant information and data, calculate the utility of the scheme, process or simulate experiments and compare the results with

established standard system. At last, they evaluate the analysis results to assess whether the design system (alternatives) can achieve each requirement and can be put into use.

Verifying scheme stage: After a project is selected, it must undertake local tests to verify the operation reliability of the scheme. If the implementation is successful, it can enter into the universal implementation phase. If all the consequences that are previously considered become potential problems, it is necessary to analyze the reason and take preventive measures to eliminate these factors. If these factors can't be eliminated, decision makers should take some emergency measures to deal with possible problems or give feedback to "track inspection" till satisfactory results are achieved.

About value judgment, explanations are needed. Every decision process contains a real element and value element. Value elements can't be tested and processed directly by any scientific method. "The judgment" and "tendentiousness opinion" are common value elements in the decision making process. The decision can't be made without such value elements as the knowledge, judgment, orientation, evaluation, selection of the main body, therefore, decision makers can't use pure natural science concepts and methods to understand and deal with decision making problems. What's more, they sometimes need to finish safety decision with auxiliary value judgment [4]

Safety decision is not a simple process of macro decision, but a particular refined person, content, management and environment. Of course, there is no doubt that three phase decision "Prior decision, Matter decision, Post decision" proposed in this paper have followed the whole process of safety decision.

3. Commonly used safety decision method

3.1. ABC analysis method

ABC analysis is to define priorities among many factors, identify the key factors that play a decisive role in the development of one thing and the secondary factors that have less influence on accident development. In addition, this method aims to resolve main problems by adopting different management and control methods for the different risk characteristics.

ABC analysis method usually divides its objects into such three categories as A, B and C. This classification way is based on table 2. [5].

Table 2. ABC category divided reference factors

degree factor	category		
	A	B	C
the severity of accident	It can cause deaths	It may cause serious injuries, serious occupational disease personnel	It may cause minor injuries
Degree of impact on the system	The whole system or two above the subsystem are damaged	A subsystem damaged or function lost	It has no much effect on the system
Property loss	It may cause serious damage	It may cause great losses	It may cause slight loss
Accident probability	It occurs easily	It may occurred	Unlikely to occur
Countermeasures difficulty	It is difficult to prevent or need large investment and consume a lot of time	It can prevent, need medium investment, not consume a lot of time	Easy to prevent, investment is not big, less time consuming

3.2. Weighted score method

Weighted score method is to compare the alternative schemes. The specific operation steps are: First, the alternative plans are divided into the corresponding items; then workers compare each plan and give relevant score; last, they count the scores, and the plan that has the highest score can be identified as the best solution.

Generally speaking, it is based on a five point to score. The plan that isn't used takes minimum point: one point; the one that is nearly used takes two points; the one that is available takes three points; the one that is good in use takes four points; the best plan can get five points [6].

3.3. The fuzzy comprehensive decision

The fuzzy comprehensive decision is a comprehensive evaluation method based on fuzzy mathematics. The comprehensive evaluation method puts qualitative evaluation into quantitative evaluation according to the membership of fuzzy mathematics theory. That is to say using fuzzy mathematics to make an overall evaluation to things or object which restricted by various factors.

Fuzzy comprehensive decision can be finished by two steps: evaluating every single factor and assessing all the factors comprehensively [5]. The basic procedure is as follows:

①Establish factors

$$U = \{u_1, u_2, \dots, u_m\} \tag{1}$$

Where, U is a factors set; u_i are all the influence factors.

②Establish weights

$$A = \{a_1, a_2, \dots, a_m\} \tag{2}$$

Where, A are factors weights, each weight should meet to the conditions:

$$\sum_{i=1}^n a_i = 1, a_i \geq 0$$

③Establish evaluation set

$$V = \{v_1, v_2, \dots, v_n\} \tag{3}$$

④Fuzzy evaluation for the single factor

$$R_i = \{r_{i1}, r_{i2}, \dots, r_{in}\} \tag{4}$$

Put the membership of single factor evaluation into matrix, as the following figure.

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & r_{ij} & \vdots \\ r_{m1} & r_{m2} & r_{m3} & r_{m4} \end{bmatrix} \tag{5}$$

⑤Fuzzy comprehensive decision

$$B = A \circ R \tag{6}$$

3.4. The decision tree analysis method

The decision tree analysis always induces two or more events and different results when analyzing the decision incident, then breaks up decision object into continuous level and unit according to the causality, and decide analysis in the picture form, from root to leaf nodes have one route, this path is a "rule".

3.5. Evaluation method of the importance degree

Evaluation method of the importance degree is suitable for complex multi-level system, particular operation is listed below: firstly, decision makers mark the ground floor object of the same index system in the important degree system \bar{f} then mark the interface layer object. Ratings results shows in the corresponding object behind, which can be expanded. The important degree system score figure shows in fig. 3. specifically.

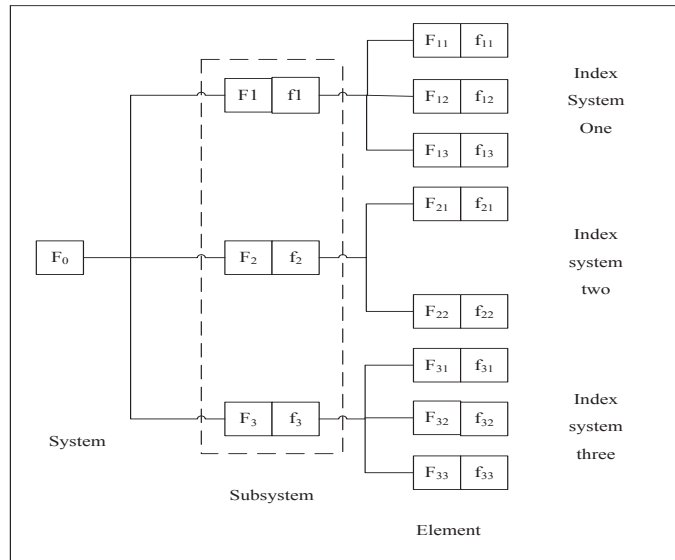


Fig. 3. The important degree system evaluation graph

Using important degree system evaluation method, all levels of element need to be normalized because it involves different levels of elements. Here are only a few examples to show the use of f_i and f_j to represent the normalization corresponding objects, and the rest can be analogized.

$$\bar{f}_1 = \frac{f_1}{f_1 + f_2 + f_3} \quad \bar{f}_2 = \frac{f_2}{f_1 + f_2 + f_3} \quad \bar{f}_3 = \frac{f_3}{f_1 + f_2 + f_3} \quad \bar{f}_{11} = \frac{f_{11}}{f_{11} + f_{12} + f_{13}} \quad \bar{f}_{12} = \frac{f_{12}}{f_{11} + f_{12} + f_{13}} \quad \bar{f}_{13} = \frac{f_{13}}{f_{11} + f_{12} + f_{13}}$$

If using f'_i and f'_{ij} to represent the final score of the corresponding object, its computation formula is as follows:

$$f'_{ij} = \bar{f}_i \bar{f}_{ij}$$

3.6. Intellectual stimulation method

Intellectual stimulation method also can be called brainstorming method; it is the application of collective wisdom, focuses on a group of professional experts with rich individual character and rich knowledge to arouse more idea countermeasures through the discussion and exchanging with each other. The most common intellectual stimulation method mainly includes: expert evaluation method, the Delphi method.

4. Discussion

In one word, there are a lot of methods that can be used for safety decision; each method has its characteristics and scope. There is no decision method that can be used in all decision-making plans. Three stages of safety decision of "decision, matter decision, post decision", each stage of decision making has its decision goal, decision task and decision contents. In addition to select the appropriate decision-making methods, we also wish to take "a decision method that integrated a variety of decision-making methods of assisted decision-making" decision-making strategies, which can be used for a decision making method with the simplification and absolutism, so as to improve the quality of the decision.

5. Conclusion

Prior decision, matter decision and post decision are proposed on different stages of the development process of acc. Three phases of the safety decision are obviously different; therefore, the same kind of decision-making method can be used for the whole process of the safety decision. After contrasting the common security decision-making method, decision makers can select the appropriate decision method for each safety decision stage, which aims to achieve the goal of "prevention before the accident, reduction in the accident process and implementations after accident rescue" and realization of the nature safety of the production process.

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