

Primary Exploration in Early Warning System of Construction Projects

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Abstract: The safety in production work, which is the important content of the construction of overall well-off society, helps our society step into full scale development. It is also the important constituent of implementing the sustainable developmental strategy. Nowadays the architecture industry development changes with each new day, thus the construction safety in production work should change correspondingly. In this article, the early warning theory was used in the construction projects originally. The article began with introducing some related concepts about safe early warning system, covered its skeleton and index system subsequently, and established the synthesis appraisal mold finally, which has explored a new method to analysis the security problem of construction project in our country.

Key words: construction project; safety warning; warning index; warning signal; warning limit.

Application of Set Pair Analysis in Safety Assessment

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Abstract: This paper applies SPA in the safety assessment, adopt the pluralistic connection number model to appraise the current safety situation of three workshops in a certain company in a city, and compare the safety states of different workshops of the same rank. Through the analysis on set pair situation, predict the development trend of the safety state of every department. This method can give a quantitative description of the operating of the system, the mathematics formula is simple, and it doesn't need relevant function, not a large amount of data, it is convenient to calculate, and thus it offers a new way for safety assessment. Difference degrees i , prove the transformation degree among the identical, discrepancy and contrary item of system, reflect the safety management levels of enterprises, it is "barometer" and "direction sign" of enterprise's safety management.

Key words: set pair analysis; safety assessment; connection degree; pluralistic connection number model; set pair situation

1 Introduction

The enterprise in order to raise the safety management level, guarantee the production activity safety carried on, has used many kinds of safety technology and safety assessment method, and obtained the remarkable result. In existing safety assessment method, like hazard index methods, probability risk assessment, fuzzy assessment^[1] and so on, although use these methods can carry on the preliminary safety assessment and the present situation safety assessment to an enterprise, but is unable to carry on the forecast to an enterprise safety condition development tendency. A system or an enterprise's safety condition has randomness, fuzziness and not complete and so on not the definite factor, thus cause the confidence level of the appraisal result to reduce and the appraisal result is insufficiently accurate. Our country scholar Zhao Keqin proposed set pair analysis in 1989, which is a processing not definite question theory method and takes relates μ as the theory cornerstone^[2], set pair analysis may unify describes and processes the determination indefinite system which randomness, fuzziness, not complete and so on not the definite factor causes. At present in the society, set pair analysis widespread application in the economy, science, technology, project and so on many domains, and has had the good economy and the social efficiency^[3-6]. This article unifies many not definite factors in the safety assessment to apply this theory, studies one new safety assessment method, causes the safety assessment more concrete and accurate.

2 Outline of set pair analysis theory

2.1 Basic principle

Set pair analysis is a new not definite theory^[7], its core thought is to deal determinism and not determinism in the system with the dialectical analysis and mathematics processing, manifests systematically, dialectical, mathematics three major characteristics. This theory believed that, the not determinism is the thing essential attribute, and took the not determinism and the determinism as a system to carry on the comprehensive survey. Set pair analysis divides the determinism into "identical" and "contrary" two aspects, but the not determinism will be called "the discrepancy", from identical, discrepancy, contrary-three aspects analyzes the thing and its system. Identical, discrepancy, and contrary mutual connection, mutual influence, mutually restrict, also mutually transforms under the certain condition. The introduction connection degree and its mathematics expression unification describes not determinism, thus will transform the not definite dialectical understanding to concrete mathematics operation.

The connection degree and its mathematics expression determines by follow^[8]:

Supposes basis question W , launches the analysis to set pair H that is made up of set A and the set B , altogether obtains N characteristics, including S characteristics center two set, these two sets in other P characteristics are contrary and in other F ($F = N - S - P$) characteristics are not definite, then did not consider the weighing to state; S/N is the identical of set A and set B under question W , the simple mark is a ; F/N is corresponding discrepancy, the simple mark is b ; P/N is contrary, the simple mark is c .

When did not consider weighing of various characteristics, the connection degree is:

$$\mu(W) = \frac{S}{N} + \frac{F}{N}i + \frac{P}{N}j = a + bi + cj \quad (1)$$

The in the formula i for the discrepancy coefficient, in $[-1, 1]$ the sector regards the different situation value, i also may only play the mark role; j is a contrary coefficient, it is -1 , similarly also may only play the mark role; μ for connection degree, when it uses as a numeral to be called the connection number.

Thus it may be known, connection degree formula contains three aspects, simultaneously manifests the relations, influence and transformation of the three aspects. When i is 1 , discrepancy transforms identical; when i is -1 , then discrepancy transforms contrary; when i in $(-1, 1)$ sector value, then the identical and contrary respectively accounts for the certain proportion.

2.2 Pluralistic connection number

Pluralistic connection number is according to the formula $U = A + Bi + Cj$ on Bi launching: $U = A + B_1i_1 + B_2i_2 + \dots + Cj$, obtained one function that has level structure. Takes $n = 2$, four variable connection number $U = A + B_1i_1 + B_2i_2 + Cj$; Takes $n = 3$, five variable connection number $U = A + B_1i_1 + B_2i_2 + B_3i_3 + Cj$, analogizes in turn, takes $n = k$ ($k \geq 2$), results in $k + 2$ ($k \geq 2$) variable connection number, generally calls it pluralistic connection number.

In order to apply conveniently, after pluralistic connection number was carried on the normalization often to rewrite as following form:

four variable connection number: $\mu = a + bi + cj + dk$

five variable connection number: $\mu = a + bi + cj + dk + el$

six variable connection number: $\mu = a + bi + cj + dk + el + fm$

Pluralistic connection number: $\mu = a + bi + cj + dk + el + fm + gn + \dots + xy$

Reference with the concept of ponderance of connection number, in pluralistic connection number $a, b, c, d, e, f, g, \dots, x$ still were called connection ponderance, followed with the connection ponderance $i, j, k, l, m, n,$

..., γ is called the connection ponderance coefficient, usually, pluralistic connection number's first item does not bring the coefficient (its coefficient is +1); last item coefficient is -1; Other each coefficient i, j, k, l, m, n, \dots regards the different situation to take the different value in $[-1, 1]$, the value principle separately has "the proportion value", "the neighbor value", "divides equally the value", as well as only makes the delamination mark use and so on; pluralistic connection number from first item to last, it's "positive" ingredient maintenance decreases progressively.

2.3 Pluralistic connection number model

The definition called μ_{CN} (IDCM) is pluralistic connection number model^[9]:

$$\mu_{CN} (IDCM) = W \cdot R \cdot E = (W_1, W_2, \dots, W_n) \begin{vmatrix} a_1 & b_1 & c_1 & \dots & x_1 \\ a_2 & b_2 & c_2 & \dots & x_2 \\ a_3 & b_3 & c_3 & \dots & x_3 \\ \dots & \dots & \dots & \dots & \dots \\ a_n & b_n & c_n & \dots & x_n \end{vmatrix} \begin{vmatrix} 1 \\ i \\ j \\ \vdots \\ \gamma \end{vmatrix} \quad (2)$$

In model $W = (W_1, W_2, \dots, W_n)$ is the weight coefficient vector, R is the identical, discrepancy and contrary - pluralistic surveys assessment matrix, E is the connection ponderance matrix, IDC is the abbreviation of identical, discrepancy and contrary, M represents the model, CN expresses pluralistic connection number.

2.4 Set pair situation

When connection degree $\mu = a + bi + cj$ ($c \neq 0$), identical and contrary ratio is the set pair situation under the certain question background, namely $shi(H) = a/c$. The set pair situation order which becomes according to the a/c value size relations is called the set pair situation order. The set pair situation rank and the order for details sees Table 1^[2,9].

3 Applications examples

Makes some enterprise's actual value of safety target and this target safety assessment criteria is two sets, composes these two sets a group. To carry on the present situation assessment to some factory three workshop, the assessment target system sees Table 2, existing three appraisers M_k ($k = 1, 2, 3$) rests on each target to carry on the assessment to three workshops, the assessment rank divides into 5 levels: safe, comparatively safer, the general safe, is more dangerous, danger. Known the appraisers' weight coefficient: $W_{M1} = 0.5$, $W_{M2} = 0.3$, $W_{M3} = 0.2$, the appraisers produce the assessment result sees the Table 3—Table 5.

Table 1 Relation between set pair situation and order

serial number	size relations between a, b and c	rank division	set pair situation	meaning
1	$a = c, b = 0$	Average trend	Standard average trend	The same trend of the identical and contrary in the system.
2	$a = c, b < a$		Obvious average trend	The identical and contrary trend in the system is obvious same.
3	$a = c, b = a$		Weak average trend	Though the identical and contrary trend in the system is equal, uncertain.
4	$a = c, b > a$		Faint average trend	Though the identical and contrary trend in the system is equal, because of uncertain function, seem very faint.
5	$a > c, b = 0$	Identical trend	Standard identical trend	The system has definite the identical trend.
6	$a > c, c > b$		Obvious identical trend	The system takes the identical trend as the core.
7	$a > c, a > b > c$		Weak identical trend	The identical trend of the system is weaker.
8	$a > c, b > a$		Faint identical trend	The identical trend of the system is very faint.

续表

serial number	size relations between a , b and c	rank division	set pair situation	meaning
9	$a < c, b = 0$		Standard contrary trend	The system has contrary the identical trend.
10	$a < c, 0 < b < a$	Contrary	Obvious contrary trend	The system takes the contrary trend as the core.
11	$a < c, b > a, b < c$	trend	Weak contrary trend	The contrary trend of the system is weaker.
12	$a < c, b > c$		Faint contrary trend	The contrary trend of the system is very faint.

Table 2 Index system of current safety management situation assessment of a certain factory

1st level of target	2nd level of target	3rd level of target
Overall safety assessment	Safety system B_1	Situation of safety education of three ranks C_1
		Personnel hold the card on duty for special homework C_2
		Implementation of the system of responsibility in safe production C_3
		Skilled intensity of the safe regulations for technical operation C_4
		Situation of rectification and improvement of the accident potential C_5
	Production scene B_2	State of safe protection facilities C_6
		Situation of the exit passageway C_7
		Safeguard procedures of the hazards C_8
		Safety sign C_9
	The teams and groups management B_3	Administrative situation of the fixture C_{10}
		Safety activity C_{11}
		Maintenance state of the apparatus and tool C_{12}
	Mechanical electric apparatus B_4	Safe situation of main electricity distribution room C_{13}
		The low-voltage electric apparatus accords with the standard situation C_{14}
		Intact situation of the apparatus C_{15}
		Intact situation of safety device of the hoisting machinery C_{16}

Table 3 Assessment result given by M_1

workshop	Assessment target																Connection degree after assessment result normalization
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	
1st workshop	A	A	C	B	C	B	D	B	A	C	A	C	A	B	B	A	$0.3750 + 0.3125i + 0.2500j + 0.0625k$
2nd workshop	A	A	A	B	B	B	A	A	A	A	B	B	A	A	A	A	$0.6875 + 0.3125i$
3rd workshop	A	A	B	B	B	B	B	B	A	A	B	C	A	B	A	A	$0.4375 + 0.5000i + 0.0625j$

Table 4 Assessment result given by M_2

workshop	Assessment target																Connection degree after assessment result normalization
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	
1st workshop	A	A	B	B	B	C	B	B	E	C	B	D	B	B	C	B	$0.1250 + 0.5625i + 0.1875j + 0.0625k + 0.0625l$
2nd workshop	A	A	A	A	A	A	A	A	A	B	B	C	B	B	C	B	$0.5625 + 0.3125i + 0.1250j$
3rd workshop	A	A	A	B	B	B	B	B	B	B	B	D	B	B	C	B	$0.1875 + 0.6875i + 0.0625j + 0.0625k$

Table 5 Assessment result given by M_3

workshop	Assessment target																Connection degree after assessment result normalization
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	
1st workshop	B	A	C	B	C	B	C	B	D	B	B	C	A	A	C	A	$0.2500 + 0.3750i + 0.3125j + 0.0625k$
2nd workshop	A	A	A	B	B	B	B	A	A	A	A	C	A	A	B	A	$0.6250 + 0.3125i + 0.0625j$
3rd workshop	B	A	A	A	B	B	B	B	B	B	B	C	A	B	B	A	$0.3125 + 0.6250i + 0.0625j$

4 Analysis and result

4.1 Based on pluralistic connection number model assessment

(1) According to the formula (2), may obtain the synthesis assessment result of three departments:

$$1\text{st workshop: } \mu_1 = 0.2750 + 0.4000i + 0.2438j + 0.0625k + 0.0187l \quad (3)$$

$$2\text{nd workshop: } \mu_2 = 0.6375 + 0.3125i + 0.0500j \quad (4)$$

$$3\text{rd workshop: } \mu_3 = 0.3375 + 0.5813i + 0.0625j + 0.0187k \quad (5)$$

(2) According to "divides equally the principle" to determine five variable connection number's connection ponderance coefficient values, and calculate connection number of each department. Stipulated by connection number $\mu = a + bi + cj$ that, $j = -1$, i in $[-1, 1]$ regards the different situation value, after expands the connection number to five variable connection number $\mu = a + bi + cj + dk + el$, $l = -1$, i, j, k in $[-1, 1]$ value. according to "divides equally the principle", $i = 0.5$, $j = 0$, $k = -0.5$, then three workshops connection number values are: $\mu_1 = 0.4751$; $\mu_2 = 0.7938$; $\mu_3 = 0.6188$.

(3) According to "divides equally the principle" determines "safe, comparatively safer, the general safe, is more dangerous, danger" the connection number value scope, because the normalized that connection number value μ only can be $[-1, 1]$ the sector, five ranks divide this sector into five parts, separately corresponds five ranks, thus it may be known, 1st workshop safety condition is "is comparatively safer"; 2nd workshop and 3rd workshop safety condition are "is safe"; and 2nd workshop overall situations fortunately to 3rd workshop, namely $\mu_2 > \mu_3 > \mu_1$.

4.2 Base set pair situation analysis

No matter the pluralistic connection number model, or the commonly used quantitative safety assessment method at present, can only carry on static safety evaluation to the system, but the safety situation of every index of the system with time thereupon changes, safe item, dangerous item and uncertainty item may transform each other, which department safety situation is the best at next moment, all unpredictable, the set pair situation can solve these problems, can predict the safety development trend of every department, point out the direction for the safety management.

Because the weight of latter two item of the formula (3) - (5) are relatively light, in order to discuss convenient to simplify three formulae to study the development trend of their safety situation, the simplify formulae as follows:

$$\mu_1 = 0.2750 + 0.4000i + 0.2438j \quad (6)$$

$$\mu_2 = 0.6375 + 0.3125i + 0.0500j \quad (7)$$

$$\mu_3 = 0.3375 + 0.5813i + 0.0625j \quad (8)$$

According to table 1 set pair situation analysis result is:

1st workshop: $a/c = 1.12$, $a/b = 0.69$, faint identical trend, the identical trend of the system is very faint.

2nd workshop: $a/c = 12.75$, $a/b = 2.04$, weak identical trend, the identical trend of the system is weaker.

3rd workshop: $a/c = 5.40$, $a/b = 0.59$, faint identical trend, the identical trend of the system is very faint.

Because formula (2) > formula (3) > formula (1), so we can find out the trend that the safety situation of three workshops takes a favorable turn is: 2nd workshop stronger than 3rd workshop, 3rd workshop is stronger than 1st workshop.

μ_2 is weak identical trend, but $a > 0.5$, even $i = -1$, all uncertainty item is transferred to dangerous item, $\mu_2 = 0.275 > 0$, safety situation of 2nd workshop still is "comparatively safer", prove, finish the daily safety inspection to 2nd workshop, rectify and improve the unsafe index, the safety situation development trend of 2nd will be steady in "comparatively safer" or "safe" state.

A is far greater than c in μ_3 , but b item is bigger as uncertainty one, prove there are few unsafe indexes in 3rd workshop, but it is more indexes in “generally safe”, causes the system easy to transformed not stably. So, safety situation of 3rd workshop is unstable, the safe trend of the system is very weak, we cannot think the appraisal result is “safe” may have no more worries, actually otherwise, actually this is not so. Strengthen the daily safety inspection, especially the “generally safe” index item, make it reach “safe” or “safer” standard, carry on safety education to staff members, improve safety consciousness, is serious about the safety work, can't slack off, could make 3rd workshop safety state develop towards “safe” direction, otherwise have careless to can develop towards “dangerous” direction slightly.

μ_1 and μ_3 are in faint identical trend, but a in μ_1 is slightly bigger than c , there is more unsafe item, look for the hazards strictly, rectify and improve, do the safety safeguard procedures well, enable staff member's skilled operation skills, improve safe consciousness. In addition, b of μ_1 item is too relatively bigger, “generally safe” index item is more, will check these items conscientiously, improve the safety standard, make it in “safe” state, prevent it transformations to unsafe. Through preceding calculation, though 1st workshop is in “comparatively safer” state, the development trend allows of no optimist, slightly neglect, will develop to average trend or contrary trend, may enter the “generally safe” or “danger” state, should cause the attention of the safety administrator, set about carrying on the safety inspection, rectifying and improving from people, France, thing, environment in an all-round way, improve the whole safety situation of 1st workshop, guarantee its good development trend.

5 Conclusions

(1) SPA adopts a certain as well as uncertain concept of connection degree to carry on quantitative describe to system, the mathematics formula of this method is simple, need not to set up relevant functions and need not a large number of data either, it is convenient to calculate, the physical meaning is clear, meaning justice is far-reaching, and the safety system is system, include a lot of confirming and uncertain factors inside, it is very suitable to apply SPA to safety assessment by research.

(2) Utilize the pluralistic connection number models in SPA to assessment the safety current situation of the workshop of one enterprise, can not only carry on the grade to divide to the safety state of every workshop but also can receive the accurate quantization result, also can find the disparity between the workshops in the same grades, offer quantitative analysis to safety administrator, make the assessment result more accurate.

(3) Through carry on the set pair situation analysis, predict out the safety situation development trend of every workshop, raise the assessment criterion virtually, has offered the important basis to administrator, have pointed out the working direction. Set pair situation is a dynamic change, but will prone to a steady state value under certain condition. Set pair situation can from one steady state enter another steady state^[10]. Fetching value of set pair degrees i , prove the transformation degree of identical, discrepancy and contrary of system, reflect enterprise's safe management level, they have consistency, is “barometer” of enterprise's safety management.

(4) Apply SPA to safety assessment, not merely carry on concrete, accurate, dynamic assessment to the safety condition of production of enterprise, and can know the degree of attention to safety work of the administrator of an enterprise, is safety direction sign of enterprise management, have important and far-reaching meanings to enterprises high-efficiently operate and ensure people's safety, offered a kind of new thinking and route for safe assessment at the same time.

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Research on Hazard Chemicals Accident Emergency Space Database Based on GIS

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Abstract: Frequent hazard chemicals accidents are terribly threatening the safety of people's lives and the ecological environment. In order to decrease and prevent the occurrence of hazard chemicals accident effectively and know complexion after an accident in time, it is necessary to build up a hazard chemicals emergency database. This article discusses the types of hazard chemicals and proposes the concept of hazard chemicals effect system. Based on it and take the GIS as the platform, a compound space database including image database, attribute database, mathematical model database and decision-making database was built up. By the general control module, the general work environment of space database was formed, so as to realize the data collecting and update, information query, dynamic simulation display, emergency analysis and assessment, assisting decision-making and so on. Every function of the space database and the process of building the space database were systematically discussed. Establishment of hazard chemicals accident emergency space database based on GIS provided an effective tool for preventing and dealing with paroxysmal hazard chemicals accidents and disasters.

Key words: GIS; hazard chemicals; emergency; space database; hazard chemicals function system

1 Introduction

The time when the rapid development of chemical industry is largely promoting human society, chemical disasters and accident caused by various causes happen frequently. They are terribly affecting the human health and the safety of the ecological environment, threatening the development of the economy and society. In order to decrease and prevent the occurrence of hazard chemicals accident effectively and know complexion after an accident in time, it is necessary to build up a hazard chemicals emergency database. Forewarning and rescue information can be provided promptly and accurately, and an integrated resolution for the emergency management of the bursting accidents and disasters can be provided by a hazard chemicals emergency database. As the development of GIS (Geographic Information System), the functions mentioned above can be realized by building an emergency space database for hazard chemicals accident on the platform of GIS.