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EVALUATION STUDIES ABOUT COLLEGE MULTIFUNCTIONAL GYMNASIUM COMPUTER EVACUATION UNDER FIRE CONDITIONS

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ABSTRACT

It's an important evaluation architecture safety standards about personnel emergency evacuation under the fire condition, from the development trend of university gymnasium, it's relatively rare that based on comprehensive evaluation the multi-functional gymnasium fire conditions personnel emergency evacuation study and there is no mature evaluation model can be applied to practical operation level. Taking the multi functional gymnasium fire evacuation and the related theory, by using the methods of expert interview and Delphi survey method, determine the relevant evaluation index set, it includes four level index, eleven secondary index and thirty three indicators, using this set of indicators can be completed the emergency evacuation evaluation under the University multi-purpose stadiums fire condition, established the University Gymnasium fire evacuation under the condition of fuzzy comprehensive evaluation model, the model is applied to a university gymnasium of emergency evacuation assessment, verification of the accuracy of the model, operation and objectivity, the multifunctional Gymnasium under the condition of fire evacuation assessment provides the reference.

Keywords: *University, Stadium, Fire, Evacuation, Evaluate*

1. INTRODUCTION

At present, our country mainly by the safety supervision mechanism according to " standard " building fire protection design for large public building supervision and check, this method can only point out its and specification phase sum deviates, could not indicate severity, also cannot evaluate the public building emergency computer evacuation of quality [1]. Moreover, this method also brought about negative effects to emergency computer evacuation management, primarily the management of emergency computer evacuation measures seriously enough, can not seize the core problem of computer evacuation and not know computer evacuation of the overall effect[2]-[4]. For large public construction emergency computer evacuation of the supervision and check often only pay attention to computer evacuation facilities, and ignore the management in the application of computer evacuation. It can be imaged that once the disaster accident happened in crowded public places, considering the serious consequences of secondary disasters, casualties could be very heavy. Large public construction of emergency computer evacuation measures only keep a high degree of validity and reliability can minimize casualties and property losses in case of a fire, so, is very necessary to establish large public construction safety computer evacuation evaluation model. The existing building fire safety assessment to establish model can be classified into two kinds, one kind is the traditional qualitative analysis, and the other is the fusion of the mathematical model of quantitative analysis of the research [3]-[6]. It's important research task and important ways to protect our campus fire security that how to start from China University Gymnasium development trend, absorb the domestic and foreign research methods and achievements in scientific research and establish more close to the actual university gymnasium under the condition of fire emergency computer evacuation assessment model[7]. However, this area of research results is rarer and there is no mature evaluation model can be applied to practical operation level. In this paper, starting from the actual needs and fire computer evacuation related theories as a guide, define the University Gymnasium fire computer evacuation evaluation, establishes an evaluation model, provides practical evaluation tool and reference for the multi functional gymnasium fire computer evacuation.

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2. THEORETICAL BASIS

4.1 Trajectory Cross Theory

What say here trajectory cross theory refers to: many interrelated sequence of events is the result of the development of cause injury. And these events including people and objects (including environment) two big development series. Injury accidents often because of unsafe behavior and physical state of insecurity in their respective development process (tracks), in a certain time, the space of the contact (cross), the energy transfer to the human body caused. And the unsafe behavior of the people and the unsafe state of object generation and development, it is affected by many factors, the basic theory is shown as shown in Figure 1.

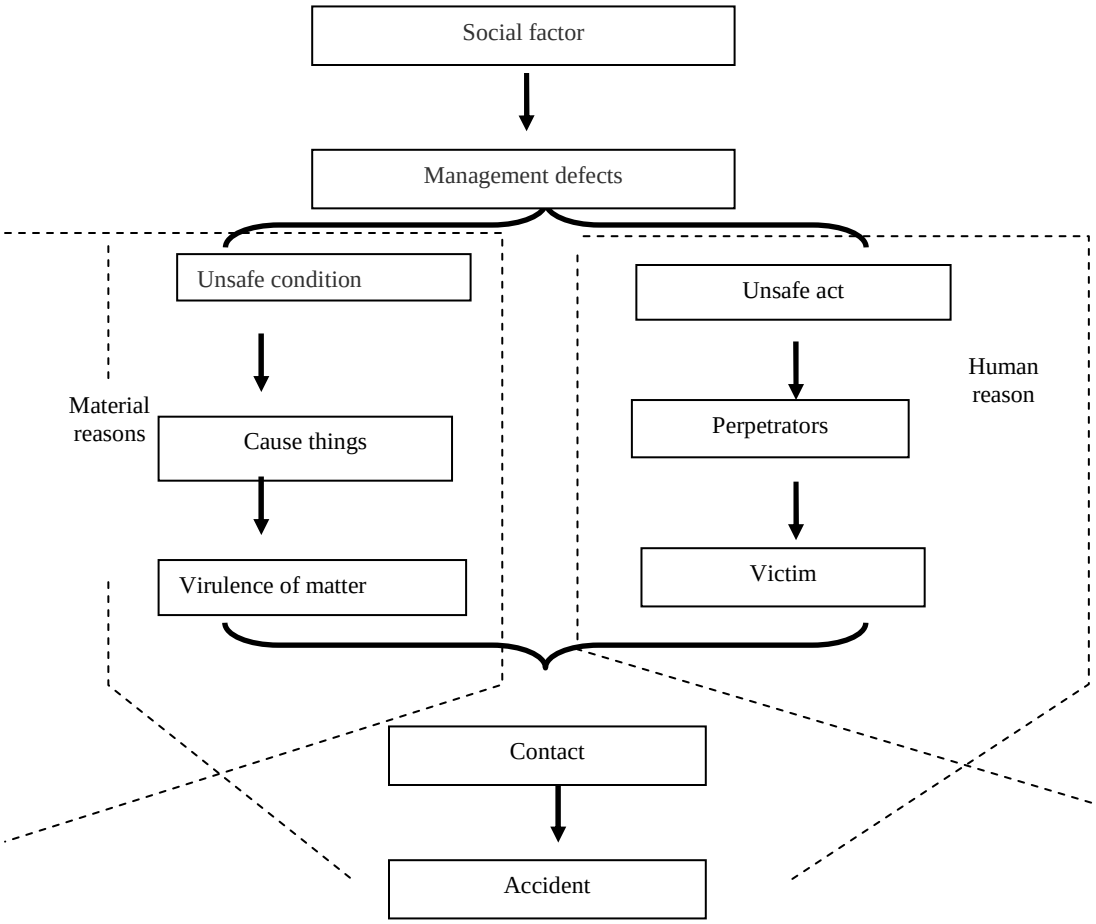

Figure 1: Trajectory Crosses Basic Theory

4.2 Sports Venues Computer Evacuation Design

At the present stage in our country, sports stadiums building computer evacuation design involves engineering specification for " code for fire protection design of buildings " and " code for design of GB50016-2006 sports building " JGJ31-2003, on the safe computer evacuation design of stadium made special provisions[8].

Sports venues when use often can form high density population, its people have the characteristics of arriving and left in focus. Focus to leave people, it belongs to a kind of diversionary crowd computer evacuation, whether it is in normal computer evacuation cases or in the emergency computer evacuation, which are all hidden a lot of security problems. Especially in the emergency computer evacuation, the crowd psychology in a state of panic, everyone hopes to be able to escape

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from the scene of the accident, as soon as possible through the inward and outward and computer evacuation channel evacuated to safety area. Once the computer evacuation process someone fall, or people in the broad and narrow corridor into the channel in the exit flow stagnation and plugging, will make people's mood more hasten is anxious tension, at a loss, and individual might even blind forward congestion or push, if this occurs, it will greatly reduce the computer evacuation efficiency, but also easy to cause accidents [9].

Therefore, sports venues building computer evacuation design must meet the following requirements:

Timely: People evacuated to safety area before the danger coming.

Security: In case of emergency computer evacuation, must guarantee that does not appear crowded, jam, trample phenomenon, that is to say, must guarantee that even in an emergency, people still can safely and smoothly to safety area.

Convenient: Evacuation design should accord with People's Daily psychological behavior requirements. And the computer evacuation process, ensure computer evacuation path, computer evacuation mouth, computer evacuation identification and obvious and easy to identify, computer evacuation route short the smooth, decrease as far as possible computer evacuation levels, avoid detour roundabout.

Benefits: In the architectural design, in meet the safety requirements for computer evacuation of the premise, should try to make the computer evacuation passageway and computer evacuation exit occupancy area economic, practical and reasonable.

Comfort: Evacuation process, also should consider the researchers were able to convenient, comfortable and reclined at the table, and lounge.

4.3 Fire Phasing

Some researchers to set up a disaster preparedness plan for the purpose, according to the different states of the fire, take control fire extinguishing action and to spatial units affected by fires understanding fire. Accordingly, fire expanding process is divided into different state division or definition into several stages, time factor as a main line through fire process always, commonly known as fire phases. Fire from happen to development, the biggest influence factor is human activity, and even be able to influence the corresponding of fire control action, the end result of the implementation of the fire phases can not only find all kinds of effective fire prevention counter measures, and provides a convenient to study each fire phase control fire behavior of the systematic method. Fire development process have different degree of risk, fire protection measures play a different degree of effect, accordingly will fire happens to initial step exhibition to spread in the whole place process is divided into four stages: The fire occurred stages; The fire spread stage; Evacuation critical stage; Building comprehensive combustion stage.

4.4 Fire Conditions Personnel Safety Computer Evacuation Criterion

Personnel can withstand environment mainly through several indicators to determine, that affect the safety of personnel in the fire visibility, toxicity, thermal radiation and convection, if any parameter does not meet the quantitative criteria, prove that the environment at this time to have a serious impact on the staff, could lead to casualties. The analysis proved computer evacuation until the environment has reached can not tolerate the conditions; you need to adjust the fire program, fully guaranteed intolerable environmental conditions before the advent of safe computer evacuation to a safe exit.

The fire smoke contains poisonous and harmful gases (such as CO, HCN, CO2, SO2) and unburnt solid product. Harmful gas in the space reach a certain concentration may cause casualties. In addition to the inhalation toxic gas may cause casualties outside, low smoke layer also may cause casualties. After the occurrence of fire smoke spread along the ceiling, the spread process, smoke layer down, when the smoke layer down to staff the height of the breath, oxygen concentration will reduce, may cause suffocation personnel casualties. So in addition to guarantee space in the concentration of poisonous gas outside, still need to maintain the fire smoke in a certain height, namely clear height, usually need to maintain the flue gas above the personnel average height level[10].

Research shows that the fire heat release nearly 70% through the convection heat transfer way into the flue gas layer. If the fire flue gas can not be discharged in time, aggregation of the flue gas temperature reaches a high temperature (usually that reached 600℃), the flue gas will be radiation much heat for fire has not yet been lit object causing the cleavage of a combustible gas, when the cleavage of the combustible gas enough, may eventually cause the scene most combustible matter in a short period of time are burning, this phenomenon is called flashover. Flashover phenomenon shows that the effect of fire in the

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human body heat mainly comes from the smoke layer heat radiation, so the control of the flue gas temperature on fire computer evacuation has positive significance.

4.5 Arching Phenomenon

During the computer evacuation process, when the gathered crowd from the broad spatial crowding into the entrance or exit of the time, apart from the front into the stream of people, usually there are a lot of people crowded into the entrance from the side, so it will impede the positive personnel flow, and then make the gathered crowd density increases, in the shape of flow structure, in the export before the emergence of instantaneous who also cannot pass through the stalemate. And when the arch of the gathered crowd density increases to a certain extent, due to a side force is relatively strong, leading to the arch of the sudden collapse, some people into the outlet, stream of people moved suddenly, so it is easy to lose balance and fall or trampling damage, especially in steps or stairs more dangerous. The old arch destroyed soon after, the new arch can form.

4.6 The Crowd Gathered Characteristics

Difficult to predictive : A large crowd gathered place as a special group, has the certain d group structure, such as population size, cohesion, communication, standard and casting, etc. As the competition venues often gathered a large group, for such a group, due to a larger population, the action is differ, to unify the will, unified command, unified action is very difficult. At the same time, large-scale group cohesion obvious than in small groups, so that a few emotional individual from the whole, cause some unexpected events occur, and external environment such as competition managers once and audience, the cohesive force and conflict will enhance, lead to conflict upgrade.

The situation is difficult to control: As is known to all, all the big game import and export quantity, and size are certain, once a serious accident, the crowd computer evacuation must immediately. And at this time, people often emotions tend to be excited. The closed form sport not only has special structure, there are other high-rise buildings do not have the high density population. In the event of a process, the high density will always maintain, and one of the individual as the basic elements and have a high degree of freedom. In this case, the game will be a series of special crowd has gathered by the risk of latent zone, and once after the accident, the height of the crowd gathered will expand the accident original effects, which lead to harm scope and degree of upgrade, and then influence the development of computer evacuation and rescue action.

3. EVALUATION MODEL INDEX SET

According to relevant theory, large public construction emergency computer evacuation indicator can be divided into special emergency computer evacuation facilities, emergency computer evacuation guidance system, computer evacuation route and computer evacuation management and plan etc. Initial setting the university multi-functional gymnasium under the condition of fire computer evacuation evaluation model index set, using Delphi method to sports venues management personnel, fire professionals of two wheel questionnaire survey, index selection, the first round of 25 were questionnaire, recovery of 25, the second round a total of 15 a questionnaire, recovery of 15, two wheel questionnaire are 100% effective. The group decision was selected and indicators and the concrete index structure see Table 1.

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Table 1: The Multi-Functional Gymnasium Under The Condition Of Fire Emergency Evacuation Evaluation Model Index Set

	Level indicators	Secondary indicators	Three indicators
The multi-function hall physical culture institute under the condition of fire emergency evacuation evaluation model index set	Structures of buildings	Emergency exit	width
			quantity
			Evacuation distance
			Set Position
		stairs	form
			width
			Smoke design
			gradient
			Surface smoothness
		Channel	width
			Wall refractory performance
			Normally closed fire door
			Channel form
	Evacuation command system	lighting	power-supply system
			Set Position
			intensity of illumination
		sign	symbolic address
			marker spacing
		broadcast	quantity
			Set Position
			voice
	Evacuation line	Evacuation line reasonable	flexibility
			Simplicity
		Evacuation route choice	irritability
	management measure	daily management	Evacuation facilities inspection
			Evacuation facilities maintenance
		Evacuation plan	evacuation drill
			Evacuation education
		Evacuation training	Responsibility Assignment
			evacuation plan

4. MODEL HYPOTHESIS

Fuzzy comprehensive evaluation as a fuzzy mathematics a specific application methods, in the field of scientific research has been widely used.

4.1 Multi-Level Comprehensive Evaluation Procedure

In the complex system, because there are many factors to consider, and between various factors and often hierarchical relationships of points, in this case, can look forward to the factors set U by some attribute is divided into several kinds, first to every kind of (factor less) comprehensive evaluation, Then the evaluation

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results are "class" between a high level of comprehensive evaluation [5], the procedures is:

Division factor set U

Factors to set U do division, namely:

U= { U1 , U2 , U3 , … , Un } (1)

Ui= { Ui1 , Ui2 , Ui3 , … , Uik } , i=1,2,3 , … , n , Namely Ui contains a factor Ki, $\sum_{i=1}^{N} K_i = n$, And satisfy the following conditions:

$$\bigcup_{i=1}^{N} U_i = U \qquad (2)$$

$$Ui \bigcap Uj = \phi \quad , \quad i \neq j \qquad (3)$$

Primary evaluation for every Kifactor of Ui= { Ui1 , Ui2 , Ui3 , … , Uik } , According to the initial model for comprehensive evaluation. Set Uifactors important degree fuzzy subset for Ai, the Ui of Ki factors and the total evaluation matrix is $\tilde{R}_i$, So get:

$$\tilde{A}_i \bullet \tilde{R}_i = \tilde{B}_i = (b_{i1}, b_{i2}, b_{i3}, \ldots b_{in})$$

i=1,2,3 , … , n (4)

b_i is the single factor evaluation of Ui.

Secondary evaluation

Suppose U= { U1 , U2 , U3 , … , Un } factors determine fuzzy subset for $\tilde{A}$, and $\tilde{A} = (\tilde{A}_1, \tilde{A}_2, \tilde{A}_3 \ldots \tilde{A}_n)$, U the general evaluation matrix $\tilde{R}$ is:

$$\tilde{R} = \begin{pmatrix} \tilde{B}_1 \\ \tilde{B}_2 \\ \tilde{B}_3 \\ \ldots \\ \tilde{B}_4 \end{pmatrix} = \begin{pmatrix} \tilde{A}_1 \bullet \tilde{R}_1 \\ \tilde{A}_2 \bullet \tilde{R}_1 \\ \tilde{A}_3 \bullet \tilde{R}_1 \\ \ldots \\ \tilde{A}_4 \bullet \tilde{R}_1 \end{pmatrix} \qquad (5)$$

That is the (level 2) comprehensive evaluation results, namely:

$$\tilde{B} = \tilde{A} \bullet \tilde{R} \qquad (6)$$

This is also focus on the factors U= { U1 , U2 , U3 , … , Un } comprehensive evaluation results, the evaluation process such as Figure 2 shows:

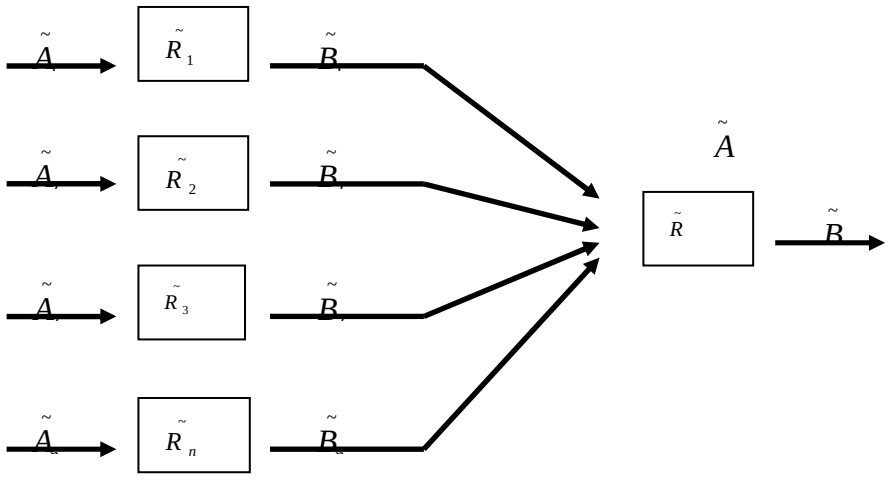

Figure 2: Secondary comprehensive evaluation model calculation procedure chart

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Above the comprehensive evaluation model can be called secondary model, If factors set U related factors involving multiple theory level, it also can be based on the model of multi-level comprehensive evaluation.

4.2 Index Weight Calculation

In the fuzzy comprehensive decision, the weight is very important, it reflects the various factors in comprehensive decision process of status or role, directly affect the result of the comprehensive decision-making. Experts estimation method is usually given by experience weight, is the main method of determining the weight.

Set factors set U= { U1 , U2 , U3 , … , Un } , Existing K experts independent each factor weight was given Ui (i=1,2,3… , n) , take all factors are the experts the weight value of the average of the factors as the final weight value. Specific formula expressed as:

$$a_i = \frac{1}{k}\sum_{j=1}^{k} a_{ij} \qquad (\ i\ =1,2,3\ldots\ ,\ n\ ) \qquad (7)$$

Namely:

$$A=(\frac{1}{k}\sum_{j=1}^{k}a_{1j},\frac{1}{k}\sum_{j=1}^{k}a_{2j},\frac{1}{k}\sum_{j=1}^{k}a_{3j},\cdots\frac{1}{k}\sum_{j=1}^{k}a_{nj},) \qquad (8)$$

The existing research results have shown that, the expert estimation method and the analytic hierarchy process (ahp) method for weights are consistent with each other, so in the study adopts expert estimation method for weight assignment is convenient and feasible.

5. MODEL CASE ANALYSIS

A university gymnasium is functional stadium, including the main hall and practice hall two main parts, Main hall for double building, fire resistance rating level. A layer of mobile stand can hold the audience of 1536 people, second fixed stand can hold the audience of 2000 people, the gym has a layer of export five, floor to have export one. A layer of floor and the stair between widths is 2.30 m - 2.50 m. mainly responsible for the gym teaching and competition, business performance and the teachers and students, such as assembly task. To test the emergency computer evacuation status, taking the multi-functional gymnasium under the condition of fire emergency computer evacuation evaluation model index as inspection standard, with fuzzy comprehensive evaluation method to evaluate, the stadium under the condition of fire emergency computer evacuation personnel on the comprehensive evaluation.

Consider of modern sports architecture for building scientific development and multi-purpose stadiums need to complicate the integration of the development trend of the specific situation, although depending on multi-functional stadium determine different indicators of weight to make the work more complicated, but it is undeniable that such is clearly more in line with the basic norms of scientific research, but also to guarantee the accuracy of the findings. In the course of the study, a total of 20 experts from the stadium management staff and the stadium within their jurisdictions fire department of the indicators twice assignment, whichever is assigned twice the average as the final data, according to experts estimate draw the indicators specific weight. In the second to weight assignment and completed the stadium fire computer evacuation under the condition of each index evaluation traits of work. Using the given above, the fuzzy comprehensive evaluation method to the gymnasium every level factors make evaluation set, and finally the first level index comprehensive evaluation.

Set:U= { B1 , B2 , B3 , B4 }

Weight:A= { 0.39 , 0.25 , 0.20 , 0.16 }

$A \bullet R$ = (0.16,0.59,0.16,0.09)

Final evaluation results showed that the stadium evaluation trend for: 16% for the optimal; 59% is good; 16% of general; 9% for the poor. Considering the structure of buildings, evacuation direction system, evacuation routes, management measures four factors, can think of the gymnasium fire evacuation evaluation level basically in good condition. But you must pay attention to the overall state assessment does not specifically reflect the status of the individual indicators, according to the actual situation of the lower scores on specific indicators targeted rectification overcome the defects, in order to protect the evacuation carried out smoothly. From the secondary evaluation results can be seen, this stadium in evacuation training link also has a lot of deficiencies, it is necessary to improve.

6. CONCLUSION

Taking the multi functional gymnasium fire evacuation involves tracks crossing theory, fire

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stage division theory, the condition of fire safety evacuation, evacuation judgment criterion in the process of arching phenomenon, a gathered crowd characteristics and other related theories as a guide, do a questionnaire survey on the relevant experts, and ultimately determine the university function the stadium under fire emergency evacuation evaluation model index. Index set includes four level index, eleven secondary index and thirty three indicators, parameter scientific, objective and reasonable, and at the same time, give full consideration to the index evaluation maneuverability, the use of indicators can be set to the university multi-function physical culture institute library for fire emergency evacuation under the condition of personnel evaluation. Aimed at the evaluation indicators set specific operation, the establishment of a university multi-purpose stadium fire evacuation under the condition of fuzzy comprehensive evaluation model, this model will each index by qualitative properties into have operability quantitative research data, and the evaluation results more objective and reasonable. Through the case analysis to verify the model accuracy, practicability and rationality, for the multi-function gymnasium fire evacuation conditions provide the feasible evaluation tools and reference.

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