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Research on Sports Events Risk Assessment Based on Grey System Theory

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Abstract: The aim of this study provides a theoretical basis to spots event organizers and proposes some pertinent recommendations on various risks of sports events. Sports events have a series of uncertain factors and various risks which certainly will bring many adverse impacts on sports events. The study makes an in-depth risk assessment on sports events through grey system theory, makes an analysis directing at various factors influencing sports event risks and makes a quantitative assessment to risks using a grey comprehensive assessment method combining a grading system. This research indicates that in sports event risks, the property risk, personal risk, liability risk, management risk and financial risk have some restrictions on sports events, especially the financial risk.

Keywords: Assessment, risks, grey system, sports events

INTRODUCTION

The rapid development of Chinese economy promotes the great-leap-forward development of various industries, in which the sport industry has made great contributions to GDP. The spots event has become an important role in sports industry in which case we must consider the inevitable risks of sports events (Helenius *et al*., 1998).

The research abroad on sports event risks has a history of more than 50 years and has formed a complete theoretical system and analytical methods. However, the concept of sports event risk has just been introduced in China for a few years, so the theoretical research and practical operation of sports event risks in China are both in the infancy (Hui *et al*., 2012).

From the view of theoretical research, the research on sports event risks in China mainly has the following limitations at present; First, most domestic studies on sports event risks are conducted from the macroscopic point of view, but the in-depth macroscopic-theory-problem studies on risk operating mechanism of specific sports events are very limited (Belonje *et al*., 2007).

Second, comparing with other research fields, Chinese research on sports event risks started later in which case its theories haven't been fully developed yet and there hasn't been a final conclusion formed on the basic classification of sports event risks.

Third, Chinese sports event risk management develops slowly and successful cases of sports event risks are few, so data information resources are very limited and this research filed extremely lacks research results of empirical analysis (Murray *et al*., 2005).

In this case, the study makes a research on sports event management according to grey performance assessment principles using a method combining qualitativeness and quantitativeness.

Grey system theory: In 1982, Chinese scholar Professor Deng Julong created a grey system theory which is a new method for uncertain problems lacking data and information. With the small-sample poor-data uncertain system having part known information and part unknown information as the object of research, the grey system theory realizes correct descriptions and effective supervisory controls of a system's operation behaviors and evolution laws mainly by generating, developing the known information and extracting valuable information (Bor-Tyng *et al*., 2012). Many systems, such as society, economy, agriculture, industry, ecology and biology, are named according to the field and scope of their research objects, but the grey system is named by color.

In cybernetics, people generally use depths of colors to describe the clear and definite degree of information (Qinbao *et al*., 2011). For instance, Ashby called the unknown objects of internal information the black box which has been universally accepted. The "black" indicates that the information is unknown; the "white" indicates that the information is fully clear and definite; the "grey" indicates that some information is definite and some information is uncertain. Accordingly, the system with fully clear and definite information is called the white system, the system with unknown information is called the black system and the system with part clear information and part uncertain information is called the grey system.

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RESEARCH METHOD

Grey comprehensive assessment method: The grey comprehensive assessment method is an integrated assessment method based on experts judgments under the guidance of grey correlation analysis theory. The process is as follows (Nevzat *et al*., 2012):

- Establish a grey comprehensive assessment model
- Make weight selections to various assessment factors
- Make a comprehensive assessment

In grey comprehensive assessment method, weight selections can be made combining the analytic hierarchy process to improve assessment accuracy (Gommes *et al*., 2010).

Grey assessment calculation formula:

- **Content:** If k_{1j}, k_{2j}, k_{j3}, …, k_{mj} is the sample array of decision-making (assessed) units i = l, i = 2, ⋯, i = m to project j and then transform the sample array of j into project j's assessment value to grey classes h = 1, h = 2, ⋯, h = n, which is called the grey statistical assessment of grey classes belonging to project j.
- **Definition 1:** Let unit k be the sample of project j and D= $\begin{bmatrix} k_{11} & k_{12} & k_{12}\dots & k_{1m} \\ k_{21} & k_{22} & k_{22}\dots & k_{2m} \\ \dots & \dots & \dots\ \dots & \dots \\ k_{m1} & k_{m2} & k_{m2}\dots & k_{m} \end{bmatrix}$ be the matrix of sample;
- Make k_{1j}, k_{2j}, k_{3j},…, k_{mj}, j = 1, 2, ⋯, m is the sample array of project j
- Let f_h be a grey class whitening function and then $\sum_{i=1}^{m} f_h\ (k_{ij})$ is the unit overall sum of j's sample array to the whitening value of grey class h
- Make $\sum_{i=1}^{m} f_h\ (k_{ij})$ be the unit grey class overall sum of j's sample array
- **Definition 2:** Let $f_h(k_{ij})$ be sample k_{ij}'s whitening value to grey class h and σ_{jk} be the real number of [0, 1] and let $M_s$be the transformation. If M_s:{$f_h(k_{ij})$}→σ_{jk}:

  M_s:{$f_h(k_{ij})$}→σ_{jk}

$$\sigma_{jk} = \frac{\sum_{i=1}^{m} f_h(k_{ij})}{\sum_{h=1}^{n}\sum_{i=1}^{m} f_h(k_{ij})}$$

$k \in K =$ {1, 2, ⋯, n}
(1)

Then

- Make σ_{jk} be the grey assessment value of project j to grey class h
- Make M_s be the grey statistics (transformation);
- Make sequence σ_j; σ_j = (σ_{j1}, σ_{j2}, …, σ_{jn}) be the grey assessment sequence of project j;
- If σ_{jk} max {σ_{j1}, σ_{j2}, …, σ_{jn}}, then project j belongs to grey class k^*, expressed as jεk^*.
- Whitening function formula:
- Whitening function $f^1{}_i(x)$

$$f_i^1(x) = \begin{cases} 1, & x < f_0 \\ (x_3 - x)/(x_3 - f_0), & x \in [f_0,\ x_2] \\ 0 & x > x_2 \end{cases} \quad (2)$$

- Medium grey class whitening function $f^k{}_i(x)$, k = 2, ⋯, s+1

$$f_i^k(x) = \begin{cases} 0, & x < f_0 \\ (x - x_{k-2})/(f_{k-1} - x_{k-2}), & x \in [x_{k-2},\ f_{k-1}] \\ (x_{k+1} - x)/(x_{k+1} - f_{k-1}), & x \in [f_{k-1},\ x_{k+1}] \end{cases} \quad (3)$$

- Last class whitening function $f^{s+2}{}_i(x)$:

$$f_i^k(x) = \begin{cases} 0, & x < x_s \\ (x - x_s)/(f_s - x_s), & x \in [x_s,\ f_{s+1}] \\ 1, & x > f_{s+1} \end{cases} \quad (4)$$

Corresponding function graph is shown in Fig. 1.

SPORTS EVENT RISKS

Connotation of sports event risks: It's known from practical experience and common sense that risks are everywhere (Siesmaa *et al*., 2011). As to the definition of risk in sports events, it can be considered that all the possibilities of harmful events presenting in the process of a sports event are sports event risks.

Classification of sports event risks: To know sports event risks on a deep level and thus avoid risks, the classification of risks is necessary. Sports event risk identification is classifying risk factors influencing the achievement of expected sports event objects and finding out the factors hierarchically according to risk classification (Swan *et al*., 2009).

According to literature review, currently academic research results on sports event risk classification can be simply concluded as follows: first, there are property risk, personal risk and liability risk according to the potential losses of sports event risks; second, there are pure risk and speculative risk according to the risk consequence of sports events; third, there are static risk and dynamic risk according to the cause of sports event risks; fourth, there are particular risk and fundamental

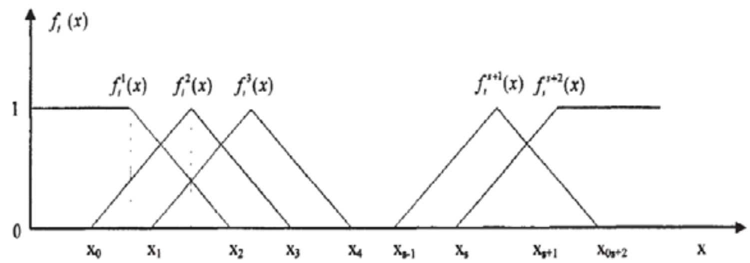

Fig. 1: Basic forms of whitening function

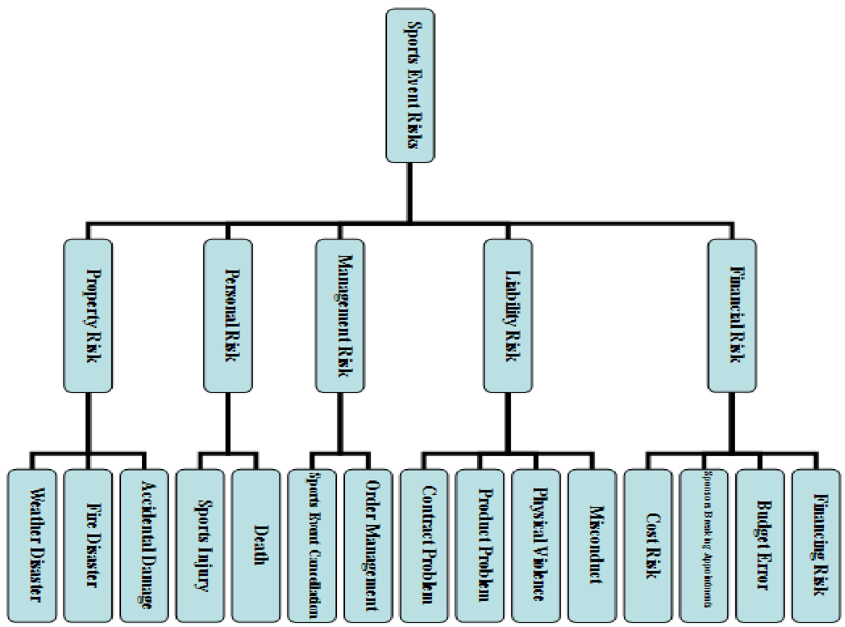

Fig. 2: Classification of sports event risks

risk according to the range affected by risks; fifth, there are natural risk and man-caused risk according to the cause of losses; sixth, there are systematic risk and unsystematic risk according to the diversifiable degree of sports event risks; seventh, there are internal risk and external risk according to the sources of sports event risks (Velani *et al*., 2012).

Concludes and summarizes the forms and causes of sports event risks on the basis of previous research studies combining the direction and form of this research (Fig. 2).

Analysis on sports event risk factors:

Property risk: The first is weather factor. Any sports event may be affected by the weather, such as extreme weathers of violent storm, high temperature and torrential rain. Weather factor mainly has two influences. First, it may affect some outdoor competition items or even suspend the competition. On September 11, 2009, the tenth competition day of the U.S. Open, the whole competition was stopped by a heavy rain and thus caused heavy losses to the organizing committee. Second, the bad weather may cause traffic jams in the host city and thus affect the audience. For instance, in Beijing 2008 Olympic Games, the Olympic Games Organizing Committee adopted an even-odd license plates driving plan to prevent the traffic paralysis risk brought by the sports event.

Fire factor mainly affects the competition area and work and rest place of sportsmen. It's particularly mentioned here because the fire factor may cause very serous consequences in a large competition. On December 15, 1999, an ultra large fire disaster broke out in one of the biggest comprehensive stadiums in Hungary's capital Budapest. The large stadium with a seating capacity of 12,500 people was basically burned down which caused a direct financial loss of more than millions of dollars and some causalities.

Personal risk: The main influencing factor of the risk is sports injury. Most games are strenuous exercises, so the unpredictable and dangerousness in a game is inevitable. The personal safety and competition risk of sportsmen are generally restriction factors in a sports event. From Beijing 2008 Olympic Games to London 2012 Olympic Games, Liu Xiang missed two opportunities to win a medal due to his Achilles tendon injury.

In addition to this, personal risk also includes food and diet safety and epidemic disease. Avoiding mass food poisoning is a key influencing factor of personal risk in a sports event. When such risk occurs, the incident may cause inestimable impacts. The influence of epidemic disease also should not be neglected. In 2003 FIFA Women's World Cup, when Chinese women football team was striving to lift the World Cup at home, a precipitate SARS forced the FIFA Women's World Cup planned to be held in China to be shifted to America.

Death is not uncommon in sports events. Such incidents mainly happen in high-risk sports events, such as Dakar Rally, skiing, surfing and F1 submarine, etc.

Management risk: Management risk includes many contents. There are two main aspects. One is the cancellation of sports events. Because of a series of factors such as weather, natural disaster and politics, the successful organization of a sports event may face many obstacles. The second is order management which is mainly reflected in playing field equipments and auditorium safety and the stability of competition order. For instance, in the opening game of Africa Cup in Estadio de Bata of Equatorial Guinea, the game hasn't begun, but fans rushed to enter the stadium and caused a wide-range jam resulting in a riot. At last, the police used tear gas to maintain order. The chaos stroke the world.

Liability risk: The influencing factors of the risk mainly direct at liability assumers. When all the possible risks have occurred, it's necessary to find out who is to blame, in which case the risk exists is liability risk. Contract problem, product problem and theft direct at the organizers of the sports event; while physical violence and misconduct direct at sportsmen and judges and sometimes audiences are also involved. For instance, in the 28^{th} round of English Premier League game of 2010, Arsenal football star Ramsey was tackled by Stoke City's Ryan Shaw cross and got shank deformed which was too horrible to look at. After that, media around the world condemned such violent football behavior the first time and expressed support for Ramsey.

Financial risk: First, cost risk is the first factor to consider when organizing a sports event. If the actual returns fail to cover the cost, the organizer and sponsor will suffer a payment imbalance risk of financial loss. Modern large sports events generally have high costs, especially some internationally known sports events for which the high cost brings high risks. For instance, Melbourne Grand Prix of Australia has been held for 8 years. Because of track reconstruction and emergency handling, the competition has lost money of 48 million dollars.

Second, sponsors may break appointments. The risk coming from sponsors is mainly reflected in their lack of long-range strategic vision and risk awareness and rush for quick results of expected returns. When they can't get expected returns in a short time, they choose to quit. For instance, in Atlanta 1996 Olympic Games, Chinese team had 37 domestic sponsors, but when the sponsors realized the sponsorship effects were not instant, they chose to quit; in Sydney 2000 Olympic Games, only one company of them remained, Li Ning; in Athens 2004 Olympic Games, Chinese team had 33 sponsors, but only 10 of them were those of the last Olympic Games. As a result, only sponsors with strategic visions like Li Ning have realized returns from sponsorship, while others are only the passersby of sponsorship.

Third, there may be a risk of loss caused by market demand budget error. Because there is not enough market research, the demand market of sports event can't be estimated correctly, resulting in a situation of "empty auditorium" which brings a risk of loss. For instance, on July 29, 2012, many stadiums in London Olympic Games had large areas of vacant seats. The London Olympic Games Organizing Committee urgently redeployed some soldiers responsible for security in the stadiums to fill the seats. The soldiers also needed to be ready for contingency operations. In addition, some Olympic Games workers and local students and teachers were also called up temporarily to make up the number.

The fourth is the financing risk. The financing risk in sports events means the risk of return changes caused by financing planning when raising funds for the sports events. The funds of a large spots event needs a large portion of financing, but the loss of profits caused by interest rate and exchange rate has some risks.

QUANTITATIVE ASSESSMENT OF SPORTS EVENT RISKS

Determination of risk level:

Expert grading: In the past, many sports event risk assessments were dominated by the qualitative analysis and the research of quantitative analysis is very limited. The qualitative research tries to make a special explanation for particular cases or objects; while the quantitative research aims to find out the general patterns of human behaviors and give universal explanations to objects in various environments. In this case, to achieve the quantitative objective, totally eight experts long engaging in risk assessment of various industries and insiders in sports circle were consulted and interviewed.

Table 1: Grading results

Sports event risks															
		Property risk		Personal risk		Management risk		Liability risk				Financial risk			
Experts grading	Weather disaster	Fire disaster	Accidental damage	Sports Injury	Death	Sports event ancellation	Order manag ement	Contract problem	Product problem	Physical violence	Misco nduct	Cost Risk	Sponsors breaking appointments	Budget Error	Finan cing Risk
1	1.5	1.5	2.0	2.5	1.0	1.5	2.5	1.0	0.5	2.0	3.0	3.0	2.0	1.5	2.0
2	1.0	1.0	1.5	3.0	1.0	1.5	3.0	1.5	1.0	2.5	3.0	2.5	2.0	1.5	3.0
3	1.0	1.0	1.0	3.0	1.0	1.0	3.5	1.0	0.5	2.0	3.0	3.5	2.0	1.0	2.5
4	1.0	0.5	1.5	3.0	1.0	1.0	3.0	1.0	1.0	1.5	2.0	3.0	2.5	1.0	2.5
5	1.5	0.5	1.5	3.0	1.0	1.0	2.5	1.0	1.0	2.0	3.0	3.5	1.5	1.5	3.0
6	1.5	1.5	1.0	2.5	0.5	1.0	3.0	1.0	0.5	2.5	2.5	2.5	2.0	1.0	3.0
7	0.5	1.0	2.0	3.0	1.0	1.0	2.5	0.5	0.5	2.0	2.5	3.0	2.0	1.0	2.5
8	1.0	1.0	1.0	2.5	0.5	1.5	3.0	0.5	1.0	2.5	2.0	2.5	1.5	1.0	2.5

Table 2: Grey statistical risk assessment results summary

Object of Assessment	Grey statistical assessment sequence	Grey statistical value	Risk level
Weather disaster	(0.3419, 0.2564, 0.1709, 0.1282, 0.1026)	2.3932	Low
Fire disaster	(0.3689, 0.2459, 0.1639, 0.1230, 0.0984)	2.3361	Low
Accidental damage	(0.0000, 0.2030, 0.3214, 0.2647, 0.2122)	3.4832	Moderate
Sports Injury	(0.2401, 0.2930, 0.3414, 0.3047, 0.2122)	4.1301	Relatively high
Death	(0.3734, 0.2441, 0.1628, 0.1221, 0.0977)	2.3265	Low
Sports event cancellation	(0.3352, 0.2590, 0.1727, 0.1295, 0.1036)	2.4073	Low
Order management	(0.3210, 0.3048, 0.3211, 0.3633, 0.2114)	4.4041	High
Contract problem	(0.0000, 0.2059, 0.3204, 0.2632, 0.2105)	3.4783	Moderate
Product problem	(0.4031, 0.2326, 0.1550, 0.1163, 0.0930)	2.2636	Low
Physical violence	(0.2400, 0.2259, 0.3204, 0.2732, 0.2205)	3.4895	Moderate
Misconduct	(0.4520, 0.3059, 0.3204, 0.2832, 0.2805)	3.5012	Relatively high
Cost Risk	(0.3200, 0.3433, 0.3259, 0.2671, 0.3137)	4.6212	High
Sponsors breaking appointments	(0.3012, 0.2259, 0.3574, 0.2422, 0.2547)	3.4845	Moderate
Budget error	(0.0000, 0.2188, 0.3148, 0.2591, 0.2073)	3.4549	Moderate
Financing risk	(0.2450, 0.2459, 0.3424, 0.2732, 0.2455)	3.4954	Moderate

Code of points: The reference points are divided by levels. According to the characteristics of each subdivided assessment index, the marking criteria of grey level assessment indexes are divided into five levels: very white, white, medium grey, grey and very grey (corresponding to relevant risk levels respectively) and are assigned points of 1, 2, 3, 4 and 5 respectively. As to the risk levels falling in between, the points are 0.5, 1.5, 2.5, 3.5 and 4.5. Table 1 shows the Grading results:

Application of grey assessment method:
Use D to set up a sample matrix:

$$D = \begin{bmatrix} k_{11} & k_{12} & \cdots & k_{1m} \\ k_{21} & k_{22} & \cdots & k_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ k_{m1} & k_{m2} & \cdots & k_{mm} \end{bmatrix}$$

$$= \begin{bmatrix} 1.5 & 1.5 & 2.0 & 2.5 & 1.0 & 1.5 & 2.5 & 1.0 & 0.5 & 2.0 & 3.0 & 3.0 & 2.0 & 1.5 & 2.0 \\ 1.0 & 1.0 & 1.5 & 3.0 & 1.0 & 1.5 & 3.0 & 1.5 & 1.0 & 2.5 & 3.0 & 2.5 & 2.0 & 1.5 & 3.0 \\ 1.0 & 1.0 & 1.0 & 3.0 & 1.0 & 1.0 & 3.5 & 1.0 & 0.5 & 2.0 & 3.0 & 3.5 & 2.0 & 1.0 & 2.5 \\ 1.0 & 0.5 & 1.5 & 3.0 & 1.0 & 1.0 & 3.0 & 1.0 & 1.0 & 1.5 & 2.0 & 3.0 & 2.5 & 1.0 & 2.5 \\ 1.5 & 0.5 & 1.5 & 3.0 & 1.0 & 1.0 & 2.5 & 1.0 & 1.0 & 2.0 & 3.0 & 3.5 & 1.5 & 1.5 & 3.0 \\ 1.5 & 1.5 & 1.0 & 2.5 & 0.5 & 1.0 & 3.0 & 1.0 & 0.5 & 2.5 & 2.5 & 2.5 & 2.0 & 1.0 & 3.0 \\ 0.5 & 1.0 & 2.0 & 3.0 & 1.0 & 1.0 & 2.5 & 0.5 & 0.5 & 2.0 & 2.5 & 3.0 & 2.0 & 1.0 & 2.5 \\ 1.0 & 1.0 & 1.0 & 2.5 & 0.5 & 1.5 & 3.0 & 0.5 & 1.0 & 2.5 & 2.0 & 2.5 & 1.5 & 1.0 & 2.5 \end{bmatrix}$$

Various classes of whitening functions: The first grey class: k = 1, very white, grey number $\in$ [0, 1 and 2] and the whitening weight function is:

$$f_1(\mathrm{k_{ij}}) = \begin{cases} k_{ij}, & \mathrm{x} \in [0,1] \\ 2 - k_{ij}, & \mathrm{x} \in [1,2] \\ 0 & x \notin [0,2] \end{cases}$$

The second grey class: k = 2, white, grey number $\in$ [0, 2 and 4], the whitening weight function is:

$$f_2(\mathrm{k_{ij}}) = \begin{cases} k_{ij}/2, & \mathrm{x} \in [0,2] \\ (4 - k_{ij})/2, & \mathrm{x} \in [2,4] \\ 0 & x \notin [0,4] \end{cases}$$

The third grey class: k = 3, medium grey, grey number $\in$ [0, 3 and 6], the whitening weight function is:

$$f_3(\mathrm{k_{ij}}) = \begin{cases} k_{ij}/3, & \mathrm{x} \in [0,3] \\ (6 - k_{ij})/3, & \mathrm{x} \in [3,6] \\ 0 & x \notin [0,6] \end{cases}$$

The fourth grey class: k = 4, grey, grey number $\in$ [0, 4 and 8], the whitening weight function is:

$$f_4(\mathrm{k_{ij}}) = \begin{cases} k_{ij}/4, & \mathrm{x} \in [0,4] \\ (8 - k_{ij})/4, & \mathrm{x} \in [4,8] \\ 0 & x \notin [0,8] \end{cases}$$

The fifth grey class: k = 5, very grey, grey number $\in$ [0, 5 and ∞], the whitening weight function is:

$$f_5(k_{ij}) = \begin{cases} k_{ij}/5, & x \in [0,5] \\ 1, & x \in [5, \infty] \\ 0 & x \notin [0, \infty] \end{cases}$$

Grey statistical assessment: According to grey assessment calculation formula, grey assessment sequence can be calculated and 15 groups of sequential values of σ_1, σ_2, …, σ_{15} were obtained. The level vector of grey class is U = (1, 2, 3, 4 and 5)^T and then assessment index W = $\sigma_j \times U^T$. Results are shown in Table 2.

CONCLUSION AND RECOMMENDATIONS

The risk level of assessment objects can be seen easily from the table above and the assessment results coincide with actual results. It indicates that the significance and function of grey system theory in risk assessment have certain advantages.

The research indicates that in sports event risks, property risk, personal risk, liability risk, management risk and financial risk all have certain restrictions on sports events, especially the financial risk. It provides organizers of sports events a theoretical basis to enhance the management to financial risk and work out strategies according to local conditions to control risk factors.

The influences of sports event risk factors are not only limited to those mentioned above, but targeted and specific forecasting can prevent the influence with a great probability. Therefore, the forecasting model of grey system theory is expected to provide a theoretical basis for this.

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