

Risk Level Assessment of Pre-Organization of Football Events with Information Technology-Based Likelihood and Severity Analysis Approach

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Abstract— One of the most popular sports events in Indonesia is football. In running high-tension football matches, safety and security factors are of utmost importance. There are many potential risks in a football match that could endanger the safety of spectators, players, officials, and event organizers, such as the risk of riots. This study aims to analyze the inherent risks affecting the pre-event stage of a football match at the Gelora Bung Tomo Stadium, Surabaya. Additionally, this research analyzes and determines the risk assessment at the pre-event stage in terms of human, environmental, operational, and financial aspects using Likelihood and Severity analysis. The outcome of this research is the development of a risk assessment information system by implementing Crowd Risk Mitigation Technologies (CRMT) to support more effective and predictive risk management. The data and information processing is based on variables and indicators that affect the potential occurrence of an event (likelihood) and the adverse impact if the event occurs (severity). Indicators are assigned weighted values according to the event scale, such as low, medium, and high risks, resulting in a Risk Matrix. The risk value results will be implemented in the Crowd Risk Mitigation Technologies (CRMT) application program, which serves as a tool to facilitate the initial mapping of the pre-event conditions for a football match. This study aims to analyze Inherent Risk at the pre-event stage of a football match at Gelora Bung Tomo Stadium. The analysis process uses likelihood and severity approaches to assess the probability and impact, resulting in a Risk Matrix. The findings show that human risk has the highest relative risk index (77.5%), related to potential conflicts and violations, environmental risks have a relative risk index of 16.3%, indicating risks of facility damage, and operational risks have a relative risk index of 6.4%, indicating dominant risks related to system failures and coordination issues. The potential financial loss reaches 1.53 billion Rupiah (very high level), with the largest contribution from human risks (888 million Rupiah), followed by operational (375 million Rupiah) and environmental risks (250 million Rupiah). With a structured and cross-data approach, the Crowd Risk Mitigation Technologies (CRMT) application is implemented as a tool for assessing pre-event football risks.

Keyword —Inherent Risk; Risk Analysis; Risk Matrix; Crowd Risk Mitigation Technologies (CRMT); Football Event Management

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I. INTRODUCTION

Football, as a global phenomenon, transcends the boundaries of mere sport and has become an integral part of people's social and cultural identity [1]. The organization of large-scale matches, especially those involving historical rivalries or commonly called derby matches, consistently attracts tens of thousands to hundreds of thousands of spectators. The implications of this massive aggregation, coupled with the dynamics of supporter interaction and the complexity of event

operations, inherently create a variety of potential risks that require serious attention [2].

Historical records show that football events are often marked by potentially dangerous incidents. Cases of uncontrolled crowds, riots between supporters that lead to damage to public facilities, and even tragedies that result in fatalities clearly indicate that inadequate risk management can have fatal implications [3]. Various reports and case studies corroborate that issues such as post-event waste accumulation, clashes outside the stadium due to disproportionate allocation of guest tickets, as well as potential match delays or cancellations triggered by external tensions (e.g., feuding narratives through social media), are integral parts of the risk landscape that must be anticipated. A history of feuds or tensions resulting in sanctions, fines, and venue moves or match cancellations also correlates to significant financial losses for organizers. This shows that the impact of risk is not only limited to the physical aspect, but also extends to the economic dimension [4].

Safety and security aspects are fundamental prerequisites for the success and sustainability of large-scale events [5]. However, common practice often shows that risk management tends to be reactive, focused on post-incident countermeasures, and not optimal in

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utilizing mitigation momentum in the pre-event phase. In fact, the pre-organization phase is the most crucial period for identifying potential hazards, assessing the level of risk, and designing proactive and effective control measures [6].

Although regulatory frameworks and safety guidelines are in place, such as PER.04/MEN/1980 which governs basic safety standards, the implementation of comprehensive, structured and data-driven pre-event risk management still requires significant improvement. Conventional approaches to risk assessment are often limited in capturing the complex dynamics and multifactorial interactions inherent in high mass concentration events. Therefore, a more systematic and scalable methodology is needed to conduct risk assessment [8].

Along with the rapid development of information technology, there is a great opportunity to integrate digital systems in the entire spectrum of risk management processes. The use of this technology can facilitate efficient data collection, more accurate analysis of risk likelihood and severity, and intuitive visualization of results to support strategic decision-making before the event [9].

Based on the urgency of the problems described above, this research considers it crucial to proactively assess the level of risk in the pre-organization phase of a soccer event. By applying a likelihood and severity analysis approach supported computationally through information technology, this research is expected to present a clear risk profile. The results will form the basis for formulating more targeted mitigation recommendations, contributing significantly to improving the safety and risk management standards of soccer events in Indonesia, as well as holistically reducing the potential for incidents, protecting assets, and maintaining the reputation of all relevant stakeholders.

II. METHOD

This study adopted a quantitative descriptive approach with a cross-sectional design [1], located at Gelora Bung Tomo Stadium, Surabaya during May - August 2024. The main focus is hazard identification and risk assessment in the pre-organization phase of soccer events. A sample of expert resource persons will be selected by purposive sampling, including the organizing committee, police, stadium management, and experts related to safety and event risk management.

potential hazards and risks that may arise during the pre-organization phase of a soccer event, especially a derby match. In addition, the population also includes all key stakeholders who are directly involved in planning and implementing the safety and security aspects of the event. To obtain in-depth and comprehensive data, the research sample will be determined through purposive sampling or snowball sampling methods [11]. Expert resource persons who will be involved include representatives from the match organizing committee (panpel), security/police officers in charge of securing the event, stadium management, as well as experts or academics in the field of event or crowd safety and risk

management. This sample selection is essential to gather perspectives from those with in-depth knowledge and practical experience in risk management of soccer events, with the number of interviewees to be adjusted until data saturation is achieved

1. Data Collection Procedure

Data collection will be conducted through three main stages:

- a) Regulation of the Republic of Indonesia Police Number 10 of 2022 (Perpol 10/2022) concerning Security for the Implementation of Sports Competitions regulates the security of sports competitions by the National Police, which includes football, and is different from the regulations made by the PSSI (All Indonesia Football Association) [12].
- b) In-depth Interview: Interviews with expert sources to verify and enrich the hazard list, obtain information on existing risk controls, and obtain subjective assessments of the likelihood and severity of each hazard.
- c) Completion of Risk Assessment Form: Expert resource persons will fill in the risk assessment form containing a list of hazards with likelihood and severity scales.

2. Data Analysis Method

The collected data will be analyzed using the HIRARC (Hazard Identification, Risk Assessment, and Risk Control) method [13], with the following step.

3. Hazard Identification: Hazards will be identified from literature review, documents, and interviews, and then grouped by category (e.g., crowd, facility, external environment, or organization related).
4. Risk Assessment: Each hazard will be assessed based on likelihood and severity using a 5x5 matrix. The rating scale used is:
 - Likelihood: Rare, Unlikely, Possible, Likely, Almost Certain.
 - Severity: Insignificant, Minor, Moderate, Major, Catastrophic. The risk level will be calculated using the formula $Risk (R) = Likelihood (L) \times Severity (S)$. The results are then mapped into a risk matrix to categorize the risk level into: Low (1-5), Moderate (6-10), High (11-15), and Extreme (16-25).
5. Risk Control : Although the main focus is on the assessment, this section will implicitly address control recommendations based on the level of risk identified, taking into account the controls already in place and suggesting additional controls if required.

III. RESULTS AND DISCUSSION

The data collection process in this study involved three main stages that complemented each other. The initial stage was a literature and document study, which aimed to identify potential hazards from previous soccer event incident reports, as well as reviewing relevant risk management

regulations and guidelines, such as PER.04/MEN/1980 [14]. This initial information was then verified and enriched through in-depth interviews with expert resource persons from the organizing committee, police, stadium management and academia. These interviews not only confirmed the hazard list, but also uncovered existing risk controls and obtained subjective assessments of the

likelihood and severity of each hazard based on the experts' direct experience. Finally, the expert interviewees were asked to complete a risk assessment form, which contained an agreed list of hazards along with likelihood and severity rating scales, allowing for an initial quantification of the level of risk.

TABLE 1.
LIKELIHOODS SCALE VALIDATION RESULTS

Level	Descriptor	Explanation
5	Almost Certain	Could happen at any time Could happen once in every Regular, Big Match, Derby
4	Likely	Could happen often Could happen once in > 3 Regular Matches, > 2 Bigmatches, > 1 Derby
3	Possible	Could happen at any time Could happen once in > 4 Regular Matches, > 3 Bigmatch Matches, > 2 Derby Matches
2	Unlikely	Likely to happen rarely Could happen once in > 6 Regular Matches, > 2 Bigmatch Matches, > 1 Derby Match
1	Rare	Could only happen under certain circumstances Could happen once in > 9 Regular Matches, > 5 Bigmatch Matches, > 3 Derby Matches

TABLE 2.
SEVERITY SCALE VALIDATION RESULTS

Level	Descriptor	Explanation
5	Extreme	Death, tear gas or other chemical poisoning that spreads outside the stadium area, permanent/serious disability, causing disruption and huge financial losses > 100 Million
4	Major	Serious injury to supporter or official, temporary disability, loss of ability to continue match, major financial loss due to cancellation or damage to facilities > 50 million
3	Moderete	Moderate injury requiring medical attention, requiring medical treatment, requiring outside assistance, medical expenses major financial loss due to property damage or disruption to the match > 25 Million
2	Minor	Minor injury to supporter or official, first aid treatment, not really requiring outside assistance, moderate financial loss due to minor damage or disruption to the match > 10 Million
1	Negligible	No injury, minor or insignificant financial loss due to minor incident that does not affect the match, does not require outside assistance < 10 Million

TABEL 3.
RISK LEVEL SCALE

Range Score	Classification	Description
19 – 25	Very High (Unacceptable)	Projected Loss > 1.050 million
13 – < 19	High (Need Active Mitigation)	Projected Loss > 300 to 1.050 million
7 – < 13	Medium (Need Monitoring)	Projected Loss > 150 - 300 million
1 – < 7	Low (Acceptable)	Projected Loss 45 -150 million

The risk level is calculated using the formula Risk (R) = Likelihood (L) x Severity (S). The calculation results and risk categories can be seen in the Risk

Assessment Results Figure. Pre-Organization Risk Assessment Results of Football Derby Event [15].

TABLE 4.
DOMINANT WORK ACTIVITY RESULTS

No	Activity	Risk Impact			Total Sus-pension	Explanation	Mitigation
		M	L	O			
1	Reserved Seat Capacity > 80%	341	17	0	358	The results show that extremely high audience density can create crowds that are difficult to control, increasing risks related to safety, comfort, and crowd control impacting human and environmental risks. This finding is in line with crowd management theory which states that overcrowding can lead to panic, physical conflict, or even tragedy due to crowd pressure [15].	1. Separation of spectator zones 2. Implement digital ticket sales management to avoid the circulation of counterfeit tickets 3. Implement an online check-in system to avoid the accumulation of ticket exchanges and supporters entering without tickets due to the actions of ticket inspectors at the entrance. 4. Tightening the raid of spectators' luggage. 5. Educate supporters to prevent conflict escalation.
2	Regional Derby Matches	302	65	0	367	In derby matches, these emotions are amplified by rivalry, creating a more intense but also riskier atmosphere. Local rivalries serve as a prestige event for both teams to show they are the best in the East Java region. Such rivalries are often built on history, culture or local competitions, so spectators' emotions tend to be more easily ignited [16].	1. Strengthen coordination with security forces across the region. 2. Separation of Supporter Zones 3. Coordination of Security Improvement of Public Facilities at supporters' gathering points. 4. Educating supporters to maintain match conditions
3	History of Past Riot Conflicts	300	65	0	365	Historical conflicts that occurred in previous seasons are always a reminder or conversation between supporters which is one of the triggers for feuds or revenge between supporters. This finding is consistent with the concept of social identity theory [17], where strong group identity can exacerbate conflict between supporters	1. Separation of spectator zones 2. Increased surveillance especially in the border areas of the two teams' homebase areas 3. Tightening the raid of spectators' luggage. 4. Educating supporters to prevent conflict escalation.

CONTINUED - TABLE 4.
 DOMINANT WORK ACTIVITY RESULTS

No	Activity	Risk Impact			Total Sus-pension	Explanation	Mitigation
4	History of Last Matches Losing	292	57	0	349	A history of recent match losses to visiting teams can trigger revenge motivation, potentially increasing the intensity of negative emotions among visiting supporters, especially in the context of high-rivalry matches. A history of recent match losses to visiting teams can trigger revenge motivation, potentially increasing the intensity of negative emotions among visiting supporters, especially in the context of high-rivalry matches. Supporters who experience defeat show a 40% increase in aggressive responses to provocation [18].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
5	Team Performance is Good Winning streak > 3 Last Matches	212	41	0	253	Influencing the enthusiasm of supporters in watching matches directly to the stadium is supported by the category of derby matches. Team in good form Euphoria from winning streaks spreads quickly among supporters through the process of emotion imitation (mirroring) raising high expectations from supporters. The study shows that sports crowds with high positive emotions are prone to turn to aggression if the team fails to meet expectations [19].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
6	High Match Tension in an Effort to Improve Rankings	226	19	0	245	Shows significant impact on the emotions of supporters and the stability of the environment around the stadium. (stadium seats, guardrails) due to emotional outbursts Matches with important implications for league rankings trigger a pressure-to-win effect, where supporters and players experience increased competitive stress [20].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educating supporters to maintain match conditions
7	History of Feuds or Tensions resulting in fines or sanctions	0	20	75	95	These tensions are usually triggered by differences in views, previous rivalries and the impact on clubs and management. Highlighting the importance of preventive efforts such as stadium security, making identity cards, and providing education to prevent hooliganism [21].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
8	Comments from Influencer Accounts, Figures, Players or Former Players	89	0	0	89	Have a significant influence on public opinion, especially in the context of sports and entertainment. Their statements can influence fans' perceptions, create polarization, or even exacerbate existing tensions. Players' provocative comments about club rivalries increase the incidence of pre-match online conflicts [22].	1. Strict Monitoring of Social Media 2. Increased Security at Stadium Area 3. Educating supporters to maintain match conditions 4. Collaboration with Public Figures

CONTINUED - TABLE 4.
DOMINANT WORK ACTIVITY RESULTS

No	Activity	Risk Impact			Total Suspension	Explanation	Mitigation
9	Internal Team Tensions	89	0	0	89	Internal tensions often affect the morale of team members and can lead to team dysfunction, which in turn affects supporter support patterns, Negative emotions from players spread to supporters Internal team tensions can affect supporter behavior. This research shows that dissatisfaction with team performance can increase negative supporter behavior, potentially leading to riots or damage to public facilities. For example, supporters who feel their social identity is threatened by the team's poor performance tend to show more intense and destructive reactions [23].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
10	Guest Ticket Quota Provided 0	41	13	0	54	There is a risk of disgruntled visiting supporters who do not get tickets this can lead to a buildup outside the stadium, increasing the potential for conflict and unrest. Supporters frustrated at not being able to enter the stadium may turn their frustration to destructive actions, such as vandalism or destruction of public facilities. The inability to get tickets can trigger frustration, which according to this theory, often leads to aggressive behavior [24].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
11	External Environmental Conditions Tensions	0	20	20	40	Tense external environmental conditions, such as social or political issues, can pose a risk, increasing conflict between supporters and emotional tensions This can exacerbate the situation, incite violence, and disrupt the smooth running of the event. Governments exploit soccer rivalries to suppress dissent, turning matches into battlegrounds for wider social conflict [25].	1. Separation of Supporter Zones 2. Coordination of Security Improvement of Public Facilities at supporters' gathering points 3. Educate supporters to maintain match conditions
12	Viral or trending hashtags that contain feud narratives	0	6	20	26	Viral or trending hashtags that contain hostile narratives can pose risks. They accelerate the spread of misinformation and mobilize groups to act aggressively. Hashtags designed for controversy [26]. often become tools to mobilize mobs online, which can then migrate to physical violence. Their virality not only reflects, but also accelerates the escalation of conflict.	1. Social Media Monitoring 2. Separation of Supporter Zones 3. Coordination of Security Improvement of Public Facilities at supporters' gathering points 4. Educating supporters to maintain match conditions

Table description

M: human factor

L : environmental factor

O: operational factor

Based on the figure above, it can be seen that several hazards have Extreme and High risk levels, which require priority attention and handling. These hazards generally relate to interactions between supporters and crowd management, as well as external factors such as provocations on social media.

Determining the risk value of the human category. Determination of risk levels is carried out through a

collaborative decision-making approach with expert judgment. Based on this reference, the Risk Level value for the human category is calculated and determined according to the projected loss level with a minimum limit of 10 million and a maximum limit of > 300 million, the results in Table 5. It's provides a classification of human risk levels based on score ranges, categorized into four distinct levels: Very High (Unacceptable), High (Need Active Mitigation), Medium (Need Monitoring), and Low (Acceptable). Each risk level corresponds to a specific range of scores, from 19–25 for Very High, to 1–7 for Low. The projected financial loss associated with each risk level also varies, with Very High indicating losses greater than 300

million, High ranging from 100 to 300 million, Medium between 50 to 100 million, and Low indicating losses between 10 to 50 million. This classification aids in determining the necessary actions for risk management.

The table helps prioritize risk mitigation efforts by categorizing human risk levels based on score ranges. It highlights the urgency of intervention, with higher scores indicating greater risk and more substantial projected financial losses. Effective risk management strategies are

necessary depending on whether the level is high, medium, or low.

The table serves as a guide for assessing and addressing human risk levels. It emphasizes the need for active mitigation or monitoring based on the risk classification. By understanding the projected financial loss for each level, organizations can allocate resources effectively and implement appropriate measures to minimize potential damage.

TABLE 5.
HUMAN RISK LEVEL

Risk Level	Range Skor	Classification	Description
4	19 – 25	Very High (Unacceptable)	Projected Loss > 300 million
3	13 – < 19	High (Need Active Mitigation)	Projected Loss > 100 to 300 million
2	7 – < 13	Medium (Need Monitoring)	Projected Loss 50 to 100 million
1	1 – < 7	Low (Acceptable)	Projected Loss 10 million to < 50 million

Determining the risk value of the environmental category. Determination of risk levels is carried out through a collaborative decision-making approach with expert judgment. Based on this reference, the

Risk Level value for the environmental category is calculated and determined in accordance with the projected loss level with a minimum limit of 10 million and a maximum limit of > 250 million.

TABLE 6.
ENVIRONMENTAL RISK LEVEL

Risk Level	Range Skor	Classification	Description
4	19 – 25	Very High (Unacceptable)	Projected Loss > 250 million
3	13 – < 19	High (Need Active Mitigation)	Projected Loss > 100 to 250 million
2	7 – < 13	Medium (Need Monitoring)	Projected Loss > 50 to 100 million
1	1 – < 7	Low (Acceptable)	Projected Loss 10 million < 50 million

Determining the risk value in the operational category. Determining the risk level is done through a collaborative decision-making approach with expert judgment. Results in table 7 Based on this reference, the

Risk Level value for the operational category is calculated and determined in accordance with the projected loss level with a minimum limit of 25 million and a maximum limit of > 500 million.

TABLE 7.
OPERATIONAL RISK LEVEL SCORES

Risk Level	Range Skor	Classification	Description
4	19 – 25	Very High (Unacceptable)	Projected Losses > 500 million
3	13 – < 19	High (Need Active Mitigation)	Projected Losses > 100 to 500 million
2	7 – < 13	Medium (Need Monitoring)	Projected Losses > 50 to 100 million
1	1 – < 7	Low (Acceptable)	Projected Losses 25 million ≤ 50 million

Financial Risk Level is needed to determine the value of financial risk in the pre-organization of soccer matches. Determination of the risk level is carried out through a collaborative decision-making approach with expert judgment. The results of this analysis are agreed upon by considering that each potential risk can be

identified and assessed appropriately. Total Financial Risk Level is the sum of the financial risk level of the human category, the financial risk level of the environmental category and the financial risk level of the operational category.

TABLE 8.
FINANCIAL RISK LEVELS

Risk Level	Range Skor	Classification	Description
4	19 – 25	Very High (Unacceptable)	Projected Losses > 1,050 billion
3	13 – < 19	High (Need Active Mitigation)	Projected Losses > 300-1,050 million
2	7 – < 13	Medium (Need Monitoring)	Projected Losses > 150-300 million
1	1 – < 7	Low (Acceptable)	Projected Losses 45-150 billion

Based on the results of the research conducted on the pre-organization of the soccer event, it can be concluded that there are several important things related to risk identification and management:

1. Determination of Inherent Risks that Affect Potential Disruption

The identification of inherent risks in the pre-organization of soccer events shows that risks that cannot be completely eliminated, such as supporter riots, extreme weather, or technical problems, need greater attention. While these risks cannot be avoided, mitigation measures can be taken to reduce their impact. Each potential disruption can be categorized and managed according to its risk level [27].

2. Risk Level Assessment with Likelihood and Severity Analysis Approach

By using the likelihood (possibility of occurrence) and severity (impact) analysis approach to assess the level of existing risks. Operational risk has the highest risk score of 23 with a very high level. This shows that operational risk is the most dominant risk in terms of severity and likelihood of occurrence. Operational risks can include system or process failures, lack of coordination between parties, and other technical obstacles that have the potential to disrupt the course of the event. Meanwhile, human risk obtained a risk score of 13.03 with a high level. This risk relates to the behavior of participants, spectators, committees, or volunteers, including potential conflicts, rule violations, and negligence that impact the safety and smooth running of the event.

Environmental risk has the lowest risk score of 8.4 with a medium level. These risks include weather factors, location conditions, or other environmental impacts that can hinder the implementation of activities, although the probability and impact are relatively more controllable than other categories [28].

3. Presentation of Data and Information with the Application of Information Technology

Information technology plays an important role in presenting data and information regarding the level of risk. Through the Crowd Risk Mitigation Technologies (CRMT) application, risk-related information can be presented in a way that is more easily understood and accessed by event organizers. This application facilitates risk mapping and helps decision-makers mitigate more quickly and appropriately.

In the 2023/2024 season, Persebaya was fined Rp600,000,000 by the PSSI Disciplinary Commission. This sanction was imposed due to inappropriate supporter support patterns, including violations of the PSSI code of conduct. This case shows that problems outside the technical aspects of the match can have serious impacts, both in terms of legal, financial, and club reputation [30]. Therefore, it is important for every match organizer to conduct thorough risk identification and control before the match takes place.

Analyzing the level of risk before a soccer match is held is very important to ensure the safety, smoothness, and success of the event. Organizers can categorize risk levels into four main levels, from Low (Level 1) to Very High (Level 4). Through a scheme like the following:

1. Anticipate potential hazards from various viewpoints of audience safety, social, and environmental.
2. Make quick and measured decisions, either in the form of increased security or postponement or cancellation of matches when necessary.
3. Improve the effectiveness of coordination between all relevant parties, such as the police, TNI, transportation department, medical team, and supporters' representatives, etc.
4. Making this risk scale not just a measuring tool, but as a basis for risk management and overall strategic planning [31].

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