APPLICATION OF SERVICE BLUEPRINT AND FMEA IN SECURITY MANAGEMENT

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ABSTRACT. *Traditional security management emphasizes using bodyguards because of their strong physique and quick reactions, but this does not thoroughly evaluate and control the entire service process of security management. To overcome the shortcomings of traditional security management, the two purposes of this article are 1) to establish a service blueprint of security management to display the service process through graphic visuals; 2) using the service blueprint of security management as a basis, compute the Risk Priority Number (RPN) based on the Occurrence rating, Severity rating and Detection rating of each potential failure mode through failure mode and effect analysis to evaluate high potential failure modes of RPN and maintain them at a lowest risk. This article adopted the study of [1] where the category probability of the Rasch model is transformed into a membership function and obtained an objective RPN through Aggregate Fuzzy Score (AFS) and defuzzified AFS of the fuzzy theory. If the score of failure of the RPN is too high, it was specially evaluated and controlled to reduce risk.*
Keywords: Failure mode and effects analysis (FMEA), Fuzzy, Rasch model, Service blueprint

1. **Introduction.** Due to the diversity of society and internationalization brought on by the convenience of transportation and communication, different security problems have arisen. Therefore, the thoughts and implementation of security management change continuously. For example, because of the 9/11 incident in 2001 that shocked the whole world, the USA government approved the Homeland Security Act 2002 to establish the Department of Homeland Security to be in charge of the national security of the USA.

Traditional security management emphasized using bodyguards because of their strong physique and quick reactions, but this type of security management does not have a deep evaluation and control on the entire service process of security management. To overcome the shortcomings of traditional security management, the two purposes of this article are 1) to establish a service blueprint of security management to display the service process through graphic visuals; 2) using the service blueprint of security management as a basis, compute the Risk Priority Number (RPN) based on the Occurrence rating (O), Severity rating (S) and Detection rating (D) of each potential failure mode through Failure Mode and Effect Analysis (FMEA) to evaluate high potential failure modes of RPN and maintain them at a lowest risk.

2. Literature Review.

2.1. **Security management.** The scope of security management is vast and includes personal safety, property safety and even national security. This study focuses on personal safety where the subjects of this service are people. The people who need personal safety are mostly politicians and people with public power and the resources to complete a task. Security management is needed due to the increase in the diversity and complexities of society and the fact that most social activities are attended by large groups of people. For example, when local or international actors, actresses, singers or athletes are in any public activity or any indoor or outdoor concert or performance, there will surely be large groups of people who will attend. Therefore, these public figures have great need for personal safety, and their demand for the quality of the security service will also continue to increase. Traditional security management does not have a deep understanding and control on the entire service process of security management. Besides the inability to completely control any situation, the inability to predict risks, a lack of responsiveness, a lack of monitoring and an incomplete contingency planning can cause life-threatening situations, property damage, restrictions of freedom and even damage and delay of the project activities or affect the peaceful order.

2.2. **Service blueprinting.** Blueprinting is often applied in construction when the architect or designer shows their design concept through architectural drawings. In earlier times, the architectural drawing was recopied onto a special type of paper which produced blue lines, thus giving them the blueprints. The whole process of the blueprint is displayed through graphic visuals. Basically, a blueprint is a two-dimensional picture where the horizontal axis represents the chronological order of the whole process and the vertical axis represents the actions in the different stages. The application of blueprinting is not limited to the industrial manufacturing process. Furthermore, [2,3] believed that the delivery process of services can also be expressed through blueprinting. Using blueprints to design the service process is called service blueprinting.

[2] suggested using service blueprinting to display the visual figure of the service to assist the process designer to confirm the chronological order of service tasks, the content of policy decisions, flow of resources, customer interaction and service throughout the service process to enable the participating service providers to further understand the details of the content and process of the service. More importantly, adding clients into the service blueprints in order to separate the contacts of the service and the client's use of the line of visibility can assist process designers to set out from the client's point of view. The designers can then strengthen the service quality of the clients' contact points by thoroughly understanding the service process clients have experienced.

[4,5] suggested that, aside from the line of visibility, the line of interaction can also be used to separate the interactions between clients and onstage employees, while the line of internal interaction can be used to separate the actions of the internal support employees from those of onstage and backstage employees. Therefore, the actions of the clients, onstage employees, backstage employees and internal support employees can be separated using the line of interaction, line of visibility and line of internal interaction.

[6] suggested adding potential failure modes in the service blueprint. Finding potential failure modes in advance can add recognition points in the process, and using checklists to prevent failures in the recognition points can guarantee that the service provided in the service process is flawless.

2.3. **Failure mode and effects analysis.** Failure mode and effects analysis (FMEA) was proposed in 1960 to mainly satisfy the high reliability and safety requirements of the

aerospace industry. In 1960, the United States Department of Defense introduced FMEA to ensure high quality and established the army standard "MIL-STD-1629", revising it to MIL-STD-1629A in 1980 [3]. [7] pointed out that the International Organization for Standardization (ISO) suggested the adoption of FMEA in 1990 and incorporated it in the standard of the ISO9000 series. FMEA is an engineering technique used to verify and eliminate known and potential failures and errors before all products or services are delivered to the client. It also evaluates possible risks produced and adopts the appropriate actions to fix them. The revised FMEA has been widely applied in different fields, including aerospace, weapon manufacturing, machineries, automobiles, electronic industry, semiconductor and medical service. FMEA plays an important role in the improvement of the reliability of industries on the overall system and the quality of products and services.

According to [7], there are two types of FMEA; one type is at a designing stage where it handles and designs related activities, and the other type is used to solve problems in the manufacturing process. All FMEA analysis results are organized in an FMEA Table. Traditionally, FMEA separately considers a ten point system according to the characteristics of the product or service and calculates an RPN based on O, D, and S. The RPN can only provide the chronological order of the evaluated results. [8] considered the cost of failures as one of the evaluation standards. [9] conducted the evaluation based on the impact of failure on financial status and proposed FMERA (Failure Modes, Effects, and Financial Risk Analysis) based on maximizing the financial benefits, with a column of cost related information added to the original FMEA Table.

[10] combined the service blueprint with the FMEA and applied it in the service design. The main purpose is to evaluate all the possible points of failure of the products or service processes and then, further confirm the actions needed to eliminate all the possible losses of the process. This study used a hypermarket in Taiwan as the subject and proposed a service blueprint and FMEA and then computed for the RPN.

3. **Main Results.** This article applied service blueprinting to conducting detailed research and analysis on the workflow of the security industry and drawing a complete and detailed blueprint to describe the security service. Linking all of the processes can provide security managers with a more comprehensive and thorough understanding of the overall security service process so that they can accurately provide high quality security service.

3.1. **Case study.** Let us examine the 9/11 terrorist attacks of 2001 when four civil airlines were hijacked by terrorists. Two of them hit the World Trade Center in New York, ultimately resulting in the collapse of the Twin Towers, while another one hit the Pentagon near Washington DC and the last one crashed near Pittsburg in Pennsylvania. A total of more than 3000 people died or went missing during these events.

After this event, continuous terrorist attacks through explosions, car bombs, kidnappings, hijackings, suicide bombs, decapitations and gunshot further resulted in the deaths of more than 3000 people with 7000 people injured throughout the world. The casualties caused by terrorist attacks are really terrifying and shocking. America is the first rival of terrorists, and conversely, terrorists also America. It challenges security management all over the world.

This study took the game between the Denver Nuggets and the Indiana Pacers of the US's NBA on October 6, 2009 as an example. Players are the team's most important assets, as well as the soul of a team. Every player has priceless value, especially among professional basketball teams. As to the safety of every American player and the risk of terrorist attack, these issues are of utmost importance.

The process of the Denver Nuggets and Indiana Pacers' visit to Taiwan is divided into three parts 1) arrival at Taiwan Taoyuan International Airport until check-in at the hotel; 2) transportation from the hotel to the venue of the game and back to the hotel and 3) departing for Taiwan Taoyuan International Airport afterwards. Figure 1 shows the service blueprint of the teams from their arrival in Taiwan to their departure. As shown in Figure 1, the focuses of the security service are the entrance and exit of the hotel, the transportation to and from the game venue, the duration of the game and the running of the vehicles between the two locations. Thus, the physical evidence of this study is "hotel security operation" and "court security operation" and is shown with the dashed line in Figure 1.

The actions of the players shown with the dashed line in Figure 1 are separated into three areas namely, "hotel check-in", "vehicle operation" and "game venue". This study described the structure of the security service in the vertical axis. According to the hierarchical structure, the line of interaction, line of visibility and line of internal interaction of the security service separates the action of players, bodyguard staff, staff personnel and support into four parts. In the security service blueprint, the line of interaction mainly divides the interaction of the players and the bodyguard staff; the intersections where a vertical line passes through the line of interaction represent that the players and the staff have interactions. The line of visibility mainly divides the bodyguard staff that are seen by the players and the staff that are not seen by the players. The function of the line of internal interaction is to divide the interactions of the contact staff and the internal support staff. Aside from showing the service blueprint with a visual flowchart, FMEA is applied to these three areas and the RPN of these three areas are shown in Tables 1-3.

FMEA first considers the "potential failure mode" and then considers the "potential failure", "cause for failure", "potential effect", "control method" and "suggested measures for improvement". The risk evaluation of the degrees of S, O and D are separately obtained according to the effect, cause and current detection method of FMEA. The RPN is obtained after multiplying S, O and D, that is RPN $= S \times O \times D$. This study divided the risks of S, O and D into three levels, and the evaluation criteria of the three are separately shown in Tables 4-6.

Five experts were invited to provide their evaluation according to their expertise and the actual situation. Their original data are organized and shown in Table 7. Through the Rasch model analysis, we can find the ideal criteria every expert would use in evaluating every element. First, S, O and D are separately used to compute the category probability of each of the experts in every element. Then, this study adopted the results of [1] to transform the category probability of the Rasch model to membership function and lastly, obtain an objective RPN through the Aggregate fuzzy score (AFS) and defuzzified AFS of the fuzzy theory. In the actual management or application, fuzzy can be used to solve various problems.

In this article, the obtained RPN is arranged from highest to lowest, where the highest threshold is prioritized and RPN $= 18$ is used as the threshold. Rankings lower than 18 are considered low and are within the reasonable and safe boundary. An RPN greater than or equal to 18 is considered an RPN with high potential for failure. Thus, it is required to separate the RPN according to failure mode, effects and causes to find protective measures and then strengthen it. This study further explored the cause of failure of high potential failures, analyzed the potential effects and proposed suggestions for improvement, all of which are shown in Tables 1-3.

With regards to the points of failure of "hotel check-in" shown in Table 1, the potential failures higher than the threshold include: surrounding (RPN $= 18$), hijacking (RPN $= 18$), murder (RPN $= 24$) and sniper (RPN $= 32$). In Table 2, for the points of failure
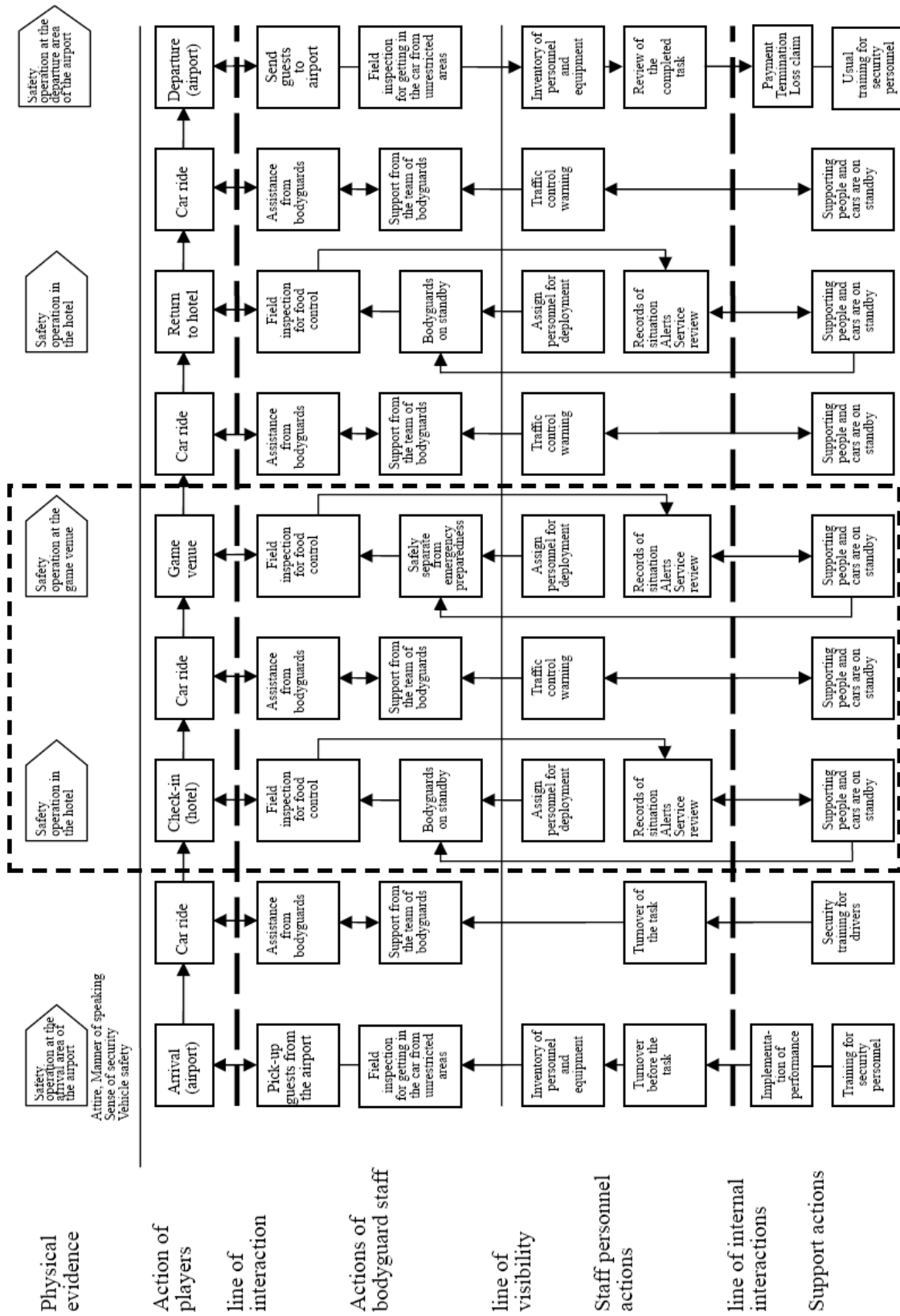
FIGURE 1. Service blueprint of the security operation

of "vehicle operation", the potential failures higher than the threshold include: car crash (RPN = 24), explosion (RPN = 32), ambush (RPN = 24) and sniper (RPN = 32). With regards to the points of failure of "game venue" shown in Table 3, the potential failures higher than the threshold are sniper (RPN = 32) and explosion (RPN = 32). It is necessary to also provide measures for the improvement of these two high risk potential failures.

3.2. **RPN.** Following the notations and the results of [1], in the partial credit model, this expectation is modeled using the Rasch model for dichotomies:

$$\frac{P_{ijx}}{P_{ijx-1} + P_{ijx}} = \frac{\exp(\theta_j - \delta_{ix})}{1 + \exp(\theta_j - \delta_{ix})}, \quad x = 1, 2, 3, \tag{1}$$

where P_{ijx} is the probability of potential failure j scoring x on expert i, P_{ijx-1} is the probability of potential failure j scoring $x - 1$ on expert i, θ_j is the potential RPN of failure j, and δ_{ix}, called a "step", is an expert parameter governing the probability of scoring x rather than $x - 1$ on expert i.

Produce triangular fuzzy numbers through the step parameters of the Rasch model and compute for the Aggregate fuzzy score. A triangular fuzzy number can be defined as a triplet (a_{i1}, a_{i2}, a_{i3}). With regards to expert i, when the score is 1, the triangular fuzzy number can be defined as a triplet $(-3, \frac{-3+\delta_{i1}}{2}, \delta_{i1})$; when the score is 2, the triangular fuzzy number can be defined as a triplet $(\delta_{i1}, \frac{\delta_{i1}+\delta_{i2}}{2}, \delta_{i2})$; when the score is 3, the triangular fuzzy number can be defined as a triplet $(\delta_{i2}, \frac{\delta_{i2}+3}{2}, 3)$. For example, in the detection (D) of Expert 2, the triangular fuzzy numbers of score 1 are $(-3.00, -2.03, -1.05)$, the triangular fuzzy numbers of score 2 are $(-1.05, 0.41, 1.86)$, and the triangular fuzzy numbers of score 3 are $(1.86, 2.43, 3.00)$. Figure 2 shows the results of Expert 2. The results of the aggregate fuzzy score of the five experts are shown in Table 8.

The Aggregate fuzzy score (AFS) is defined as AFS $= (a_1, a_2, a_3) = \left(\frac{\sum\limits_{i=1}^{5} a_{i1}}{5}, \frac{\sum\limits_{i=1}^{5} a_{i2}}{5}, \frac{\sum\limits_{i=1}^{5} a_{i3}}{5} \right)$. After step 3, which is to compute the Aggregate fuzzy score (AFS), this study applied the defuzzified AFS formula of [11], $\frac{a_1+a_2+a_3}{3}$, also called the total fuzzy score, namely the D, O and S before transformation. Then, all the D, O and S before transformation should add 3 in order to let the D, O and S be greater than 0. Afterwards, transformation is ranked accordingly and shown in Table 9.

In Table 9, there are 19 potential failures with the largest value for RPN at 76.92 and the smallest at 7.31. The RPN of this study is ranked from highest to lowest and gets the top one-third of the items. The 6 highest items considered to be high risks are C8, sniper; B1, car crash; B5, sniper; A4, murder, C9, explosion and A5, sniper. The bottom one-third items are also obtained. The 6 lowest items considered to be low risks are C3, surrounding; C1, stampede; C2, disturbance; B3, hijacking; C5, sabotage (car) and C6, hijacking. The other 7 items are considered moderate risks.

Based on the example of the NBA players from the USA, there are three most important potential failure modes (Tables 1-3). The following are the RPN of the potential failures: In Table 1, there are 2 high risks in "hotel check-in" (RPN): A4. Murder (64.63), rank 4 and A5. Sniper (49.09), rank 6. There are 3 moderate risks: A3. Hijacking (42.65), rank 7; A1. Surrounding (41.09), rank 8 and A2. Sabotage (25.60), rank 11. There are no low risks in this potential failure because this is the venue where the teams stayed the longest, and naturally, the risks are higher and more important than those in other venues.

TABLE 1. FMEA's risk priority number (RPN) of "hotel check-in"

Potential failure modes	Potential failure	Cause of failure	Potential effects	Availability of control methods	D	O	S	RPN	Suggested measures for improvement
Hotel check-in	1. surrounding	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the hotel and pay attention to suspicious behavior around the hotel. 3. The police are unable to coordinate with the special police to control the order of the scene and break-outs and arrest criminals.	D: Request reinforcement immediately. Take the player away from the scene or shield the player to a safe place and request the police to go to the crime scene and collect necessary evidence. E: The player is surrounded and is unable to attend or the game must be cancelled.	Yes					1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the hotel beforehand and pay attention to any suspicious behavior. 3. Coordinate with special police to control the order of the scene and break-outs and arrest criminals.
	2. sabotage	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the hotel, parking lot and pay attention to suspicious behavior around the hotel.	D: Request reinforcement immediately. Request the police to go to the scene of the crime and collect the necessary evidence. Request reinforcement immediately to strengthen the maintenance of the security of the hotel perimeter. E: The vehicle is damaged and the game is possibly suspended.	Yes					1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the hotel and the parking lot beforehand and pay attention to any suspicious behavior. 3. Coordinate with the police to keep in contact. Solve the problem immediately and arrest the criminal.
	3. hijacking	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the hotel and pay attention to suspicious behavior around the hotel. 3. The police are unable to coordinate with the special police to control the order of the scene and break-outs and arrest criminals.	D: Request reinforcement immediately. Take the player away from the scene or shield the player to a safe place and request the police to go to the crime scene and collect necessary evidence. E: The player is hijacked and hurt or and is unable to attend or the game must be cancelled.	Yes					1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the hotel beforehand and pay attention to any suspicious behavior. 3. Coordinate with special police to control the order of the scene and break-outs and arrest criminals.

4. mur-der	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the hotel doors and monitor suspicious characters entering the kitchen. 3. Did not assign experts to monitor the kitchen, taste their meals and pay attention to the safety of the intake of food and drinks.	Yes	D: Contact the doctor traveling with the team immediately for initial inspection. Immediately contact the police to collect evidence from the scene of the crime and take the player to the emergency room in the ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	1. Control and analyze the anti-American and anti-team public opinions and ensure that no suspicious character enters the kitchen. 2. Coordinate with the police and investigate related personnel to arrest criminals and request the ambulance to assist in sending players to the hospital.
5.sniper	1. The organizers do not pay attention to the surroundings of the public places, the exits, car stops, and the inside of the premises that criminals might attack the premises, spaces or things. 2. Staff cannot effectively and immediately check, control and monitor suspicious people and things.	Yes	D: Form a wall covering the player and immediately leave the scene. Confirm the direction of the attack and immediately contact the police to go to the scene of the crime, collect evidence and forensics and provide the position of the criminal to facilitate the arrest. Take the injured player to the hospital by ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	1. The organizers should pay attention to the surroundings of the public places, the exits, car stops, and the inside of the premises that criminals might attack the premises, spaces or things. This should be one of the priorities of the staff. 2. Make rounds to the important locations to monitor and control suspicious people and things. 3. Take the players out from the line of the premises; coordinate with the police and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment.

TABLE 2. FMEA's risk priority number (RPN) of "vehicle operation"

Potential failure modes	Potential failure	Cause of failure	Potential effects	Availability of control methods	D	O	S	R P N	Suggested measures for improvement
Vehicle operation	1. car crash	1. When the driver is not paying attention to the road in front, the traffic and vehicles act suspiciously around the vehicle. 2. Staff can't effectively and immediately control and monitor suspicious people and vehicles.	D1: Immediately take the player away from the scene of the crash or move to a safe place for cover; at the same time inform the police, disperse and arrest suspected criminals or seize the vehicle. D2: Request reinforcements and deploy to prepare the replacement for the damaged vehicles. E: Cause injuries to players and spectators that force them to suspend or cancel the game.	Yes					1. The driver should pay attention to the traffic and monitor the road in front for suspicious vehicles 2. Effectively coordinating with the police can instantly control and monitor suspicious people and vehicles. 3. Select a good vehicle with good driving performance and condition. 4. Prepare back-up vehicles in case of damage or failure.
	2. explosion	1. Failed to note that the surroundings of the route might be a cover for criminals to stash their explosives. 2. Staff can't effectively and immediately control and monitor suspicious people and things.	D1: Immediately remove the explosive from the player or move to a safe place for cover; also alert staff immediately to evacuate spectators and guide them away from the direction of the explosion. D2: Immediately report to the police, eliminate scene control, collect evidence and forensics and rescue casualties to avoid the situation from getting worse. E: Cause injuries to players and spectators that force them to suspend or cancel the game.	Yes					1. Take note of the surroundings of the route that might serve as a cover for criminals to stash their explosives. 2. Drivers should provide special monitoring and attention to the key premises in the surroundings for suspicious actions. 3. Take the players away from the explosion premise; if needed, coordinate with the bomb squad, police and the ambulance to standby on the scene to rapidly get the explosives from the scene and receive the ambulance for medical treatment.

			Yes	
3. hijacking	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to enhance the routes to grasp the situation and pay attention to suspicious signs along the road. 3. The police are unable to coordinate with the patrols to arrest the criminals.	D: Request reinforcement immediately. Request the police to go to the scene of the crime and collect necessary evidence. Immediately take the player away from the scene or shield the player to a safe place. E: The player is hijacked and hurt and is unable to attend or the game must be cancelled.	Yes	1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign a staff to monitor the routes to grasp the situation and pay attention to suspicious signs along the road. 3. Coordinate with the police patrols and bodyguards and arrest criminals.
4. ambush	1. Failed to note that the route might be a cover for criminals to attack the premises. 2. Bodyguard staff can't effectively and immediately control and monitor suspicious people and things.	D: Immediately take the vehicles of the team and leave the scene of the crime. Immediately contact the vehicle of the police to go to the scene of the crime to facilitate the arrest. Take the injured player to the hospital by ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	Yes	1. Take note of the surroundings of the route that might serve as a cover for criminals to attack the premises. 2. Drivers should provide special monitoring and attention to the key premises in the surroundings for suspicious actions. 3. Take the players away from the line of the premises; coordinate with the police and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment.
5. sniper	1. Failed to note that the route might be a cover for criminals to attack the premises. 2. Bodyguard staff can't effectively and immediately control and monitor suspicious people and things.	D: Immediately take the vehicles of the team and leave the scene of the crime. Confirm the direction of the attack and immediately contact the police to go to the scene of the crime, collect evidence and forensics and provide the position of the criminal to facilitate the arrest. Take the injured player to the hospital by ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	Yes	1. Take note of the surroundings of the route that might serve as a cover for criminals to ambush the people. 2. Drivers can use binoculars to provide special monitoring and attention to the key premises in the surroundings for suspicious actions. 3. Take the players away from the line of the premises; coordinate with the police and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment.

TABLE 3. FMEA's risk priority number (RPN) of "game venue"

Potential failure modes	Potential failure	Cause of failure	Potential effects	Availability of control methods	D	O	S	RPN	Suggested measures for improvement
Game venue	1. stampede	1. Unable to control the situation of the area of the stadium and neglect the public sentiments and reactions. 2. Did not properly plan for the in and out flow of the stadium and did not add entrances and exits. 3. Failed to properly put an appropriate number of planning staff to ease and control order.	D: Immediately request additional personnel to maintain order, to appease the masses and to reconsider moving lines, entrances and exits. E: The players and the people are injured or delay the entering time and (opening) to the stadium.	Yes					1. Control the situation around the stadium and control the increase of the crowd. 2. Coordinate with the police in advance depending on conditions to enhance ease into the scene to maintain order and train the attitudes of service personnel. 3. Coordinate with the police and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment.
	2. disturbance	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the stadium and pay attention to suspicious behavior around the stadium. 3. Unable to coordinate with the police to maintain and control order, limit the stadium and take people away from danger.	D: Closely monitor the venue and request reinforcement immediately. Request the police to go to the scene of the crime and collect necessary evidence to avoid the problem from getting bigger. E: The players and the stadium are disturbed and the game is temporarily cancelled.	Yes					1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the stadium beforehand and pay attention to any suspicious behavior. 3. Coordinate with special police to control order the scene, limit the stadium and take people away from trouble.
	3. surrounding	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the stadium and pay attention to suspicious behavior around the stadium. 3. The police are unable to coordinate with the special police to control order at the scene and break-outs and arrest the criminals.	D: Request reinforcement immediately. Request the police to go to the scene of the crime and collect necessary evidence and take the player away from the scene or shield the player to a safe place. E: The player is surrounded and is unable to attend or the game must be cancelled.	Yes					1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the stadium beforehand and pay attention to any suspicious behaviors. 3. Coordinate with special police to control order at the scene and break-outs and arrest the criminals.

4. stands collapse	1. Failed to survey for safety in advance, including checking the structure of the stands and load constraints. 2. Failed to enhance the ease of the excessive concentration of people in the stands and did not properly plan moving lines and evenly distributed the crowd in the public seating area.	D: Immediately alert, divert and guide people to leave the danger zone. Coordinate with the police and the ambulance to standby on the scene to collect evidence and rescue the injured. Request reinforcements to strengthen security around the stadium. E: Stands collapse, causing casualties in criminal cases and to the game must be cancelled or suspended.	Yes	1. Survey, test and control the structure and load limit of the stands in advance. 2. Properly plan moving lines and evenly distribute the crowd in the public seating area. 3. Coordinate with the police and the ambulance to standby on the scene. Take people away from the danger zone if any danger arises.
5. sabotage (car)	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the stadium and parking lot and pay attention to suspicious behavior around the stadium.	D: Request reinforcement immediately. Request the police to go to the scene of the crime and collect the necessary evidence. Request reinforcement immediately to strengthen the maintenance of security of the stadium perimeter. E: The vehicle is damaged and the game is possibly suspended.	Yes	1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the stadium and the parking lot beforehand and pay attention to any suspicious behavior. 3. Coordinate with the police to keep in contact to solve the problem immediately and arrest the criminal.
6. hijacking	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of the stadium and pay attention to suspicious behavior around the hotel. 3. The police are unable to coordinate to control order with the special police to control order at the scene and break-outs and arrest criminals.	D: Request reinforcement immediately. Request the police to go to the scene of the crime and collect necessary evidence. Immediately take the player away from the scene or shield the player to a safe place. E: The player is hijacked and hurt and is unable to attend or the game must be cancelled.	Yes	1. Control and analyze the anti-American and anti-team public opinions to monitor suspicious people and things. 2. Assign staff to monitor the surroundings of the hotel beforehand and pay attention to any suspicious behavior. 3. Coordinate with special police to control order at the scene and arrest the criminals.

No.	Failure mode	D / E		Recommended action
7. murder (food and beverages)	1. Unable to control the anti-American and anti-team public opinion and neglect the public sentiments and reactions. 2. Failed to strengthen the monitoring of food and beverage and monitor suspicious characters that enter the concession stand. 3. Did not assign experts to monitor the pantry, taste their meals and pay attention to the safety of the intake of food and drinks.	D: Contact the doctor traveling with the team immediately for initial inspection. Immediately contact the police to collect evidence from the scene of the crime and take the player to the emergency room using the ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	Yes	1. Control and analyze the anti-American and anti-team public opinions and ensure that no suspicious character enters the pantry. 2. Coordinate with the police and investigate related personnel to arrest criminals and request the ambulance to assist in sending players to the hospital.
8. sniper	1. The organizers do not pay attention on the surroundings of the stadium, the exits, car stops, and the inside of the premises that criminals might attack the premises, spaces or things. 2. Staff cannot effectively and immediately check, control and monitor suspicious people and things.	D: Form a wall covering the player and immediately leave the scene of the crime. Confirm the direction of the attack and immediately contact the police to go to the scene of the crime, collect evidence and forensics and provide the position of the criminal to facilitate the arrest. Take the injured player to the hospital by ambulance. E: Cause injuries to players that force them to suspend or cancel the game.	Yes	1. The organizers should pay attention to the surroundings of the stadium, the exits, car stops and the inside of the premises that criminals might attack the premises, spaces or things. This should be one of the priorities of the staff. 2. Make rounds of the important locations to monitor and control suspicious people and things. 3. Take the players away from the line of the premises; coordinate with the police and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment.

| 9. explosion | 1. The organizers do not pay attention on the surroundings of the stadium, the exits, car stops, and the inside of the premises that criminals might attack the premises, spaces or things.
2. Staff cannot effectively and immediately check, control and monitor suspicious people and things. | D1: Immediately remove the explosive from the player or move to a safe place for cover; also alert the staff immediately to evacuate the spectators and guide them away from the direction of the explosion.
D2: Immediately report to the police, eliminate the scene control, collect evidence and forensics and rescue casualties to avoid the situation from getting worse.
E: Cause injuries to players and spectators that force them to suspend or cancel the game. | | | Yes | | | 1. The organizers should pay attention to the surroundings of the stadium, the exits, car stops, and the inside of the premises that criminals might attack the premises, spaces or things. This should be one of the priorities of the staff.
2. Make rounds of the important locations to monitor and control suspicious people and things.
3. Take the players away from the line of the premises; coordinate with the police, fire brigade and the ambulance to standby on the scene for rapid control of the scene and to receive the ambulance for medical treatment. |

TABLE 4. Evaluation criteria of the frequency of occurrence (O)

Level	Rating	Definition
Frequent	3	An incident will most probably occur
Occasional	2	An incident will probably occur
Remote	1	Almost no incident will occur

TABLE 5. Evaluation criteria of the degree of severity (S)

Level	Rating	Definition
Catastrophic	3	The incident will cause death
Major	2	The incident will suspend the game or the itinerary
Minor	1	The incident will attract spectators

TABLE 6. Evaluation criteria of the chance of detection (D)

Level	Rating	Definition
High	1	It's easy to identify the causes or sources of the incident
Medium	2	It's moderately easy to identify the causes or sources of the incident
Low	3	It's very difficult to identify the causes or sources of the incident

TABLE 7. The original data of the five experts

	Otential failure	Detection (D) /Expert					Occurrence (O) /Expert					Severity (S) /Expert				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
A1	1. Surrounding	3	1	1	2	3	3	2	2	3	2	2	2	2	2	3
A2	2. Sabotage	2	1	2	2	2	2	2	2	3	2	2	2	2	2	2
A3	3. Hijacking	3	2	2	2	2	2	2	3	1	3	3	2	2	2	2
A4	4. Murder	3	2	2	2	3	3	2	2	2	3	2	2	3	3	2
A5	5. Sniper	3	2	3	3	2	3	2	1	2	2	3	3	1	3	1
B1	1. Car crash	3	2	2	1	2	3	3	3	3	3	3	2	2	3	2
B2	2. Explosion	3	3	1	2	1	2	2	2	2	2	3	3	3	3	1
B3	3. Hijacking	2	1	2	2	2	2	2	2	2	2	2	2	1	2	2
B4	4. Ambush	3	2	2	2	1	2	2	2	2	1	2	2	2	3	2
B5	5. Sniper	3	3	3	3	2	2	2	1	2	3	2	3	2	3	2
C1	1. Stampede	1	1	1	1	1	3	3	3	2	3	2	2	1	2	3
C2	2. Disturbance	1	2	1	1	2	3	3	3	2	3	1	1	1	2	2
C3	3. Surrounding	2	1	2	1	2	3	2	2	2	2	1	2	1	1	1
C4	4. Stands collapse	2	2	3	2	1	1	1	1	2	2	2	3	2	3	3
C5	5. Sabotage (car)	2	1	2	2	2	3	2	2	2	2	1	2	2	1	2
C6	6. Hijacking	2	2	2	2	1	2	2	2	1	2	3	2	2	2	2
C7	7. Murder (food and beverages)	2	2	3	3	2	1	2	1	1	2	2	2	2	3	3
C8	8. Sniper	3	3	2	3	2	2	2	3	1	3	3	3	3	3	2
C9	9. Explosion	3	3	2	2	1	2	1	3	1	3	3	3	3	3	3

TABLE 8. The results for the aggregate fuzzy score

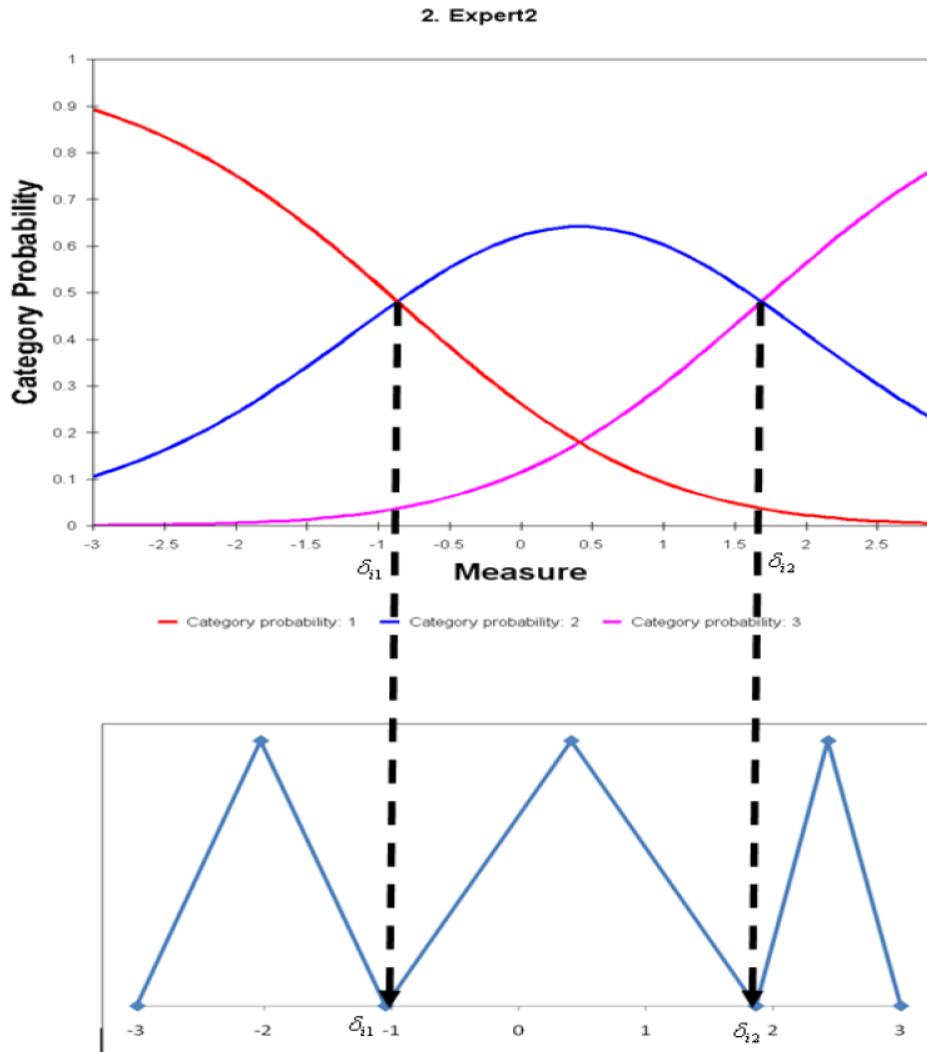| Scoring	Triangular fuzzy numbers	Detection (D) Expert					AFS	Occurrence (O) Expert					AFS	Severity (S) Expert					AFS
		1	2	3	4	5		1	2	3	4	5		1	2	3	4	5	
1	Upper bounds (a_{i1})	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
	Middle point (a_{i2})	-2.95	-2.03	-2.39	-2.39	-2.02	-2.36	-2.65	-2.71	-2.15	-1.97	-3.10	-2.52	-2.33	-3.26	-1.83	-2.67	-2.34	-2.49
	Lower bounds (a_{i3})	-2.89	-1.05	-1.77	-1.77	-1.04	-1.70	-2.30	-2.41	-1.30	-0.94	-3.20	-2.03	-1.65	-3.51	-0.66	-2.34	-1.68	-1.97
2	Upper bounds (a_{i1})	-2.89	-1.05	-1.77	-1.77	-1.04	-1.70	-2.30	-2.41	-1.30	-0.94	-3.20	-2.03	-1.65	-3.51	-0.66	-2.34	-1.68	-1.97
	Middle point (a_{i2})	-1.45	0.41	0.05	0.05	0.93	0.00	-0.65	0.43	0.18	1.13	-1.10	0.00	0.04	-0.73	1.08	-0.76	0.37	0.00
	Lower bounds (a_{i3})	0.00	1.86	1.88	1.88	2.90	1.70	1.01	3.27	1.66	3.20	1.00	2.03	1.73	2.06	2.82	0.83	2.41	1.97
3	Upper bounds (a_{i1})	0.00	1.86	1.88	1.88	2.90	1.70	1.01	3.27	1.66	3.20	1.00	2.03	1.73	2.06	2.82	0.83	2.41	1.97
	Middle point (a_{i2})	1.50	2.43	2.44	2.44	2.95	2.35	2.01	3.14	2.33	3.10	2.00	2.52	2.37	2.53	2.91	1.92	2.71	2.49
	Lower bounds (a_{i3})	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

FIGURE 2. The schematic diagram of the transformation of the category probability of the Rasch to triangular fuzzy numbers

In Table 2, there are 2 high risks in "vehicle operation": B1. Car Crash (68.4), rank 2 and B5. Sniper (65.31), rank 3. There are 2 moderate risks: B2. Explosion (39.14), rank 9 and B4. Ambush (27.55), rank 10. There is only 1 low risk: B3. Hijacking (18.24), rank 16. In Table 3, there are 2 high risks in "game venue": C8. Sniper (76.92), rank 1 and C9. Explosion (52.32), rank 5. There are 2 moderate risks: C7. Murder (Food and Beverages) (23.93), rank 12 and C4. Stand Collapse (20.22), rank 13. There are 5 low risks: C6. Hijacking (19.87), rank 14; C5. Sabotage (Car) (19.03), rank 15; C2. Disturbance (12.71), rank 17; C1. Stampede (9.58), rank 18 and C3. Surrounding (7.31), rank 19.

4. **Conclusion.** For a long time, people often engaged themselves in a number of routine operations in the security management system, but some details were often overlooked, which caused threats to the life of the person being protected or affected the program operation of the activities. This study used risk management and security as demands and applied the FMEA to identifying characteristics of the danger and developing relevant actions to establish high preventive measures. This study showed a visual flowchart using a service blueprint. First, this study confirmed the range of the failure modes and found the

TABLE 9. RPN and rank for before/after transformation

Potential failure		before			after			RPN	Rank
		(D)	(O)	(S)	(D)	(O)	(S)		
A1	1. Surrounding	0.02	0.92	0.47	3.02	3.92	3.47	41.09	8
A2	2. Sabotage	−0.49	0.39	0.00	2.51	3.39	3.00	25.60	11
A3	3. Hijack	0.59	0.43	0.47	3.59	3.43	3.47	42.65	7
A4	4. Murder	0.99	1.15	0.90	3.99	4.15	3.90	64.63	4
A5	5. Sniper	1.54	0.06	0.53	4.54	3.06	3.53	49.09	6
B1	1. Car crash	0.10	2.51	1.00	3.10	5.51	4.00	68.40	2
B2	2. Explosion	−0.08	0.00	1.48	2.92	3.00	4.48	39.14	9
B3	3. Hijack	−0.49	0.00	−0.58	2.51	3.00	2.42	18.24	16
B4	4. Ambush	0.00	−0.40	0.54	3.00	2.60	3.54	27.55	10
B5	5. Sniper	1.95	0.15	1.19	4.95	3.15	4.19	65.31	3
C1	1. Stampede	−2.35	2.12	−0.11	0.65	5.12	2.89	9.58	18
C2	2. Disturbance	−1.28	2.12	−1.56	1.72	5.12	1.44	12.71	17
C3	3. Surrounding	−0.97	0.53	−1.98	2.03	3.53	1.02	7.31	19
C4	4. Stand collapse	−0.11	−1.50	1.65	2.89	1.51	4.65	20.22	13
C5	5. Sabotage (car)	−0.49	0.53	−0.86	2.51	3.53	2.15	19.03	15
C6	6. Hijack	−0.59	−0.62	0.47	2.41	2.38	3.47	19.87	14
C7	7. Murder (food and beverages)	0.95	−1.49	1.00	3.95	1.51	4.00	23.93	12
C8	8. Sniper	1.47	0.43	2.02	4.47	3.43	5.02	76.92	1
C9	9. Explosion	0.40	−0.20	2.49	3.40	2.80	5.49	52.32	5

potential failure mode operation in the process and provided rankings for each potential failure. Then, the Rasch model was used to obtain the objective risk index. Afterwards, we divided the risks into high, moderate and low risks and suggested actions to each potential failure to be used for future reference.

The results can serve as a reference to strengthen the actions in each process. Aside from focusing intensive guidance on human factors, the strengthening actions typically adopted should emphasize the strength and improvement of security management to serve as preventive measures of risk. After the analysis, this study explored and described the following principles, according to the results.

(1) Identification of high risk factors under failure mode

In a preliminary safety service roadmap, the high risks were identified by applying FMEA. With Table 1 through Table 3, the high potential risk value of failure at each failure point in term of "hotel", "transportation" and "basketball court" could be projected. Classify the risk priority index of potential into high, moderate and low risks and arrange item 1 to 19 in order with the Rasch model. Accordingly, you may find the protection procedures by failure mode, impact and cause and thus make improvements. Table 1 to Table 3 further discuss the potential failure under high, moderate and low risks, analyze their potential influences and propose recommendations to reinforce corresponding measures.

(2) Provide high quality safety management

FMEA is analysis in advance instead of remedy procedures afterward. The safety management institute can only collect written information, such as general introductions, websites and news in advance to achieve the best precautionary effects. It is necessary to control timing and speed when performing security procedures. Controlling the possible failure points in advance may provide the highest quality of safety management.

(3) Reinforce educational training of security personnel

Personal safety management provides services to "people". You all know that changes in people are the most difficult to control and how to control the resulting situations is the top priority in terms of providing the highest level of security. There might be accidents and conditions encountered on duty anytime, and different training and precautions may be provided depending on classification to reduce human problems and negligence.

(4) Be equipped with advanced devices and equipment

"To do a good job, one must first sharpen one's tools". Security services must have good detection devices, as well as equipment that can prevent dangers, prior to performing sound safety management. In regards to the continuous threats of our current complicated society and the limited capabilities of security personnel, high-tech detection devices that help professional security to perform tasks will be an inevitable choice for identifying danger with advanced detection devices before the occurrence of unknown dangers and can eliminate the danger in an extremely short period of time.

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