

# Risk Assessment of Hip-Hop Dance and Cheerleading Athlete's Daily Training Based on FMEA

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**Abstract**—This paper carried out hip-hop and Cheerleading risk survey, classification and analysis for professional college athletes. Firstly, the risk factors and injuries in daily training are studied statistically based on questionnaire; then according to the former data, the potential risk factors are analyzed, which established the evaluation of categories, single factor and multivariate; finally, the daily training FMEA was establish, which combine ALARP principle with respect to potential risk factors, and suggestions were given for prevention and improvement. Our research has constructive significance to avoid or prevent risk in daily training and competition.

**Keywords**- risk identification; risk analysis; ALARP; FMEA

## I. INTRODUCTION

During sport training and performance, the possibility of Physical Risk [1] [2] significantly increases, along with the fluctuation of risk factors and physical conditions of the athletes. One of the main factor can be recognized as the university students who participate in hip-hop dance and cheer leading have different background of dancing and physical condition, especially, hip-hop dance requires unique body balance which distinguishes it from other form of dancing. Individual cognitive can cause divergences in choreograph dance, not to mention individual physical coordination produces divergences during training, which can generate different risk [3]. Additionally, Individual's seemingly similar situation may perceive different risk perception characteristics. The complexity bring great changes in Hip-hop and cheerleading training.

SHI [5] analyzes the main risk factors among physical education organization, and summarizes major accidents in recent years. TIAN [6], FISCHHOFF [7], LINDELL [8] puts forward the psychological factors affection on student athletes, but there are few which focus on risk factors on daily train.

In our research, we focused on the risk assessment and analysis on Hip-hop and cheerleading training of college students. First, we categorized the risk factors, injuries of

daily training based on the questionnaire we created specifically for our research, then according to the risk identification, category, univariate and multivariate evaluation were given; finally daily training Failure Mode and Effects Analysis (FMEA) was established with respect to as low as reasonably practicable (ALARP), and further prevention and improvement were given.

## II. RISK ASSESSMENT PROCESS

Risk analysis can be categorized into two ways, narrow and broad, narrow risk analysis refers to quantitative analysis required to complete tasks at given cost, schedule, performance, which can be achieved through their PDF. The broad risk analysis is a way to identify and measure risks, development, selection and management of programs to address these risks needs. Which includes risk identification, risk assessment and risk management. We adopted the latter definition in our research. Risk analysis was divided into four areas, namely: problem definition; hazard analysis; risk assessment; risk management (Figure 1).

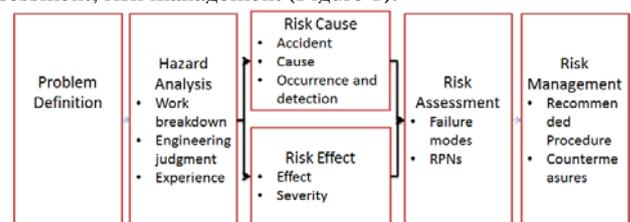


Figure 1. RISK ASSESSMENT PROCESS

### A. Risk Perception

The train time, situations have lots of possibilities, which brought difficulties in our research. Furthermore, In view of the improvement of risks, adjusting the balance of risks for sports participants, and understanding the potential risks and safety can contribute measures objectively. FISCHHOFF [6] showed that there exists a balance between subjective and objective risk, when people being exposed to a certain risk event, their desires will generally not reduce this risk

arbitrarily, they prefer to adjust their behavior to maintain this balance. That is, people would be willing to accept a certain level of risk.

The Problem identification data was from questionnaires which generated specifically suited for our research, which took the survey of 9 college students who participate in Hip-Hop and cheerleading, 116 valid surveys out of 200, the ratio of male vs. female and age distribution are showing in figure 2 & 3:

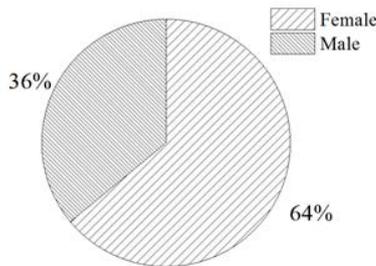


Figure 2. THE GENDER RATIO OF MALE AND FEMALE ATHLETE

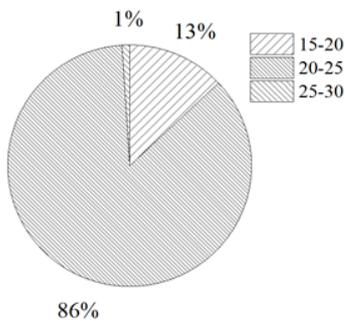


Figure 3. THE AGE DISTRIBUTION

Prior experience of professional training in dance is necessary for understanding the assessment process of train risk, which can eliminate individual differences and also the subjective aspect of comprehensive cognitive differences. Following figures shows the professional dancing training before Hip-Hop and Cheerleading.

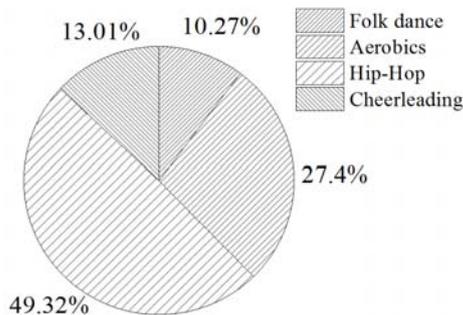


Figure 4. PRIOR DANCE TYPES

### B. Risk Identification Standards

It is very constructive to analysis risk in to categories during training, the value of severity, occurrence and detection need to be determined based on the corresponding

risk criteria. Generally, ALARP principle is adopted to determine whether the risk is acceptable or further measures are necessary. Figure 6 shows ALARP principle. If the assessment of risk factors below negligible line, then falls into the negligible zone, at this point, this risk is acceptable, and no longer need to take any safety improvements. If the assessment of risk factors between negligible line and intolerable line then fell into the tolerance zone, and it will be divided into two levels, the level of risk at this time meet the ALARP principle in figure below.

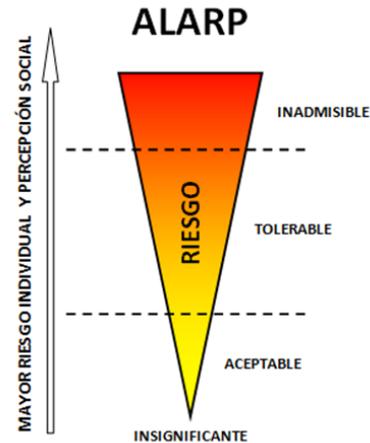


Figure 5. ALARP PRINCIPLE (WIKIPEDIA.ORG)

## III. FMEA IN DAYLY TRAINING

### A. FMEA

FMEA (FMECA) is an inductive reasoning single point of failure analysis and a core task in reliability engineering, safety engineering and quality engineering method for risk assessment. In our analysis, the FMEA assigns a numerical value to each risk associated with a failure, using severity, occurrence and detection as metrics. Severity refers to the impact of the failure model. Occurrence refers to the likelihood that the failure will occur. Detection refers to rate the likelihood that the cause of failure will be detected before a failure can occur. Risk priority number (RPN) which can be used to analyze the process is then calculated by multiplying the severity, the occurrence and the detection of the risk. So the risky elements of the design can be measured by the rank of high value RPNs. Particularly, RPN can be used to sort the problems in analysis, but in actual FMEA, high-level of severity, high RPN values should be first taken into account for evaluating corrective measures prevention project. This order must be observed to reduce the risk levels: severe degree, occurred degree, detection degrees

### B. WQS and FMEA

Windchill Quality Solutions (formerly Relx) was chosen for risk assessment, which a fully integrated software suite considered the industry's most powerful reliability analysis toolkit. Harbin Engineering University has been an active part of WQS since 2010, which includes:

- 1) Reliability Prediction
- 2) OpSIM/RBD
- 3) FMEA
- 4) FTA
- 5) ETA
- 6) Weibull
- 7) FRACAS
- 8) Markov
- 9) Maintainability Prediction
- 10) LCC
- 11) ALT

The FMEA model was chosen, which share data of reliability prediction, and the data entry forms can be level-of-indenture or spread sheet.

#### IV. FMEA APPLICATION AND RISK ASSESSMENT

##### A. FMEA Analysis

Generally, the FMEA includes 4 steps: (a) establishment of system information, (b) analysis, (c) improvement measures recommendation, (d) output of report. In this paper, the process of training was analyzed by means of FMEA on the basis of the principles and procedures. According to the assessment results on the questionnaire collected from some specialists and documents, the rationality and feasibility of the application of FMEA was finally confirmed. Table 1 through 3 indicate the RPN components for FMEA

TABLE I. SEVERITY RATING SCALE FOR FMEA

Scale	Description	Criteria
4	Catastrophic	Person die and structure scrapped
3	Critical	Person injured and structure damaged
2	Marginal	Time delay
1	Minor	Brief pause

TABLE II. OCCURRENCE RATING SCALE FOR FMEA

Scale	Description	Criteria
9~10	Frequent	Probability of occurrence is greater than 0.1
7~8	Reasonably probable	Probability of occurrence is less than 0.1 but greater than 0.01
5~6	Occasional	Probability of occurrence is less than 0.01 but greater than 0.001
3~4	Remote	Probability of occurrence is less than 0.001 but greater than 0.00001

1~2	Extremely unlikely	Probability of occurrence is less than 0.0001
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TABLE III. DETECTION RATING SCALE FOR FMEA

Scale	Description	Criteria
8~10	Almost impossible	No know monitoring methods available to detect the failure
6~7	Low	Low likelihood current monitoring methods will detect the failure
4~5	High	Good likelihood current monitoring methods will detect the failure
1~3	Almost certain	Current monitoring methods almost always will detect the failure

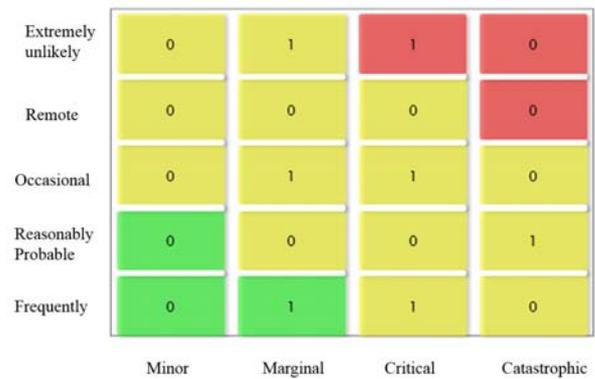


Figure 6. CRITICALITY MATRIX

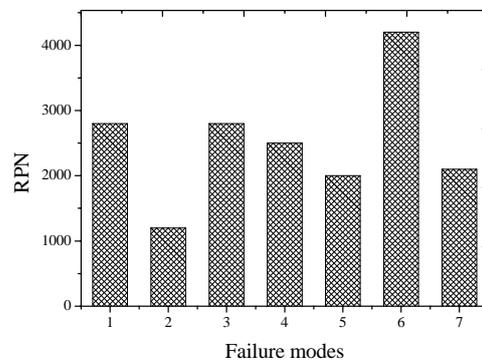


Figure 7. RPN VS. FAILURE MODES

The FMEA process and sheet is showing below:

Item Name	Item Description	Failure modes	Cause of Failure	End Effect	Occurrence	Severity	Detection	RPN	Recommended Actions
Warm-up preparations	Prepares the athlete for more intense movements requiring speed and strength.	1 Sprain during Warm-up	Individual capacity; Floor, pole problems; improper use of equipment; improper cloth	Train cannot proceed properly, seriously affect	Occasional	Critical	8	2800	Stop training for individual, receive fully treatment,
		2 Tired of training psychologically	Psychological fluctuations after injury; expectation beyond oneself	Train cannot proceed slightly training	Reasonably Probable	Marginal	4	1200	Psychological coordinate by advisors

Daily training (individual)	Individual training ability contains: upgrading; Coordination training; difficult moves; lifts.	3 Sprains (elbows, etc.)	Individual capacity; Floor, pole problems; improper use of equipment; improper cloth	Train proceed slightly training cannot properly, affect	Frequent	Marginal	7	2800	Stop training, receive fully treatment,
		4 Collision injuries	Floor, pole problems; improper coordination; individual ability	Train proceed seriously training cannot properly, affect	Remote	Catastrophic	10	2500	Stop training for individuals, receive fully treatment,
Daily training (group)	Group training includes: routing; formation of routing, lifting, breaking coordination.	5 Conflicts between athletes	Psychological fluctuation after injuries; unachieved higher expectations; conflicts between members	Train proceed slightly training cannot properly, affect	Occasional	Marginal	10	2000	coordinate by advisors
		6 Wrong coordination: lifting errors	Differences between individuals' ability; injuries; random variables; flooring problems	Train proceed seriously training cannot properly, affect	Frequent	Critical	6	4200	Stop training, initiate full physical therapy
		7 Venues and audio damages	Technical issues; mal-operations by staff	Train proceed seriously training cannot properly, affect	Reasonably probable	Critical	4	2100	Coordination by advisors

### B. FMEA Result and Suggestion

Based on the research, we can find that the coordinate action such as lifting etc. will cause great potential risk, certain standard rules should be established for this pattern, also along with presents of advisors, integrity of equipment. In mode three, particular attention should be paid for daily training, not only by raising individual quality but also by the guidance from their advisors, to keep the risk awareness.

Another serious problem in our questionnaire is that part of the athletes don't take potential injuries and injuries seriously. There are random exist during daily training, 82.8% do not have medical specialists dealing with injuries, and for injury awareness survey, only 11.2% will take thoroughly physical examination, furthermore, when experiencing injuries such as sprain, only 28.4% express the willingness to take thoroughly examination.

From the perspective of risk analysis, in most accidents, human factors accounted for the major impact, if the athlete's awareness of the risks raising, which will greatly improve. Based on the risk assessment and experience in training, we made the following recommendations

a) periodic diagnostic / counseling, starting with a clear goal, studies showed that: psychological factors in the training and competition was played, as well as to achieve the effect accounted for the major part of the team to help build a positive attitude towards the correct daily training, which will gradually help athletes to achieve a positive attitude. Respectively suggested training early, middle and late development of different strategies, if necessary, physiological consult can be introduced to the team, that is, one on one counseling to increase their self-confidence.

b) The team's medical standards should be strengthened, accompanied with medical equipment and professional doctor. Periodic checks should be taken on the team, injury statistics also can bring further improvement on training methods, for instance, in our survey, elbow injuries appeared more than other injuries, and we can address this situation by recommending that players wear the appropriate protective gear according to the situations.

### V. CONCLUSION

Based on the statistic survey of questionnaire, teaching and training experience, the risk assessment for Hip-Hop and cheerleading daily training was established, which categorized the risk factors and injuries. According to the risk identification, univariate and multivariate evaluation were given. FMEA and correlation analysis were given based on ALARP principle, which completed the following work:

a) The risk identification, evaluation, assessment and management are given for daily training.

b) Based on the questionnaire and survey, the FMEA of Hip-Hop and cheerleading were established in WQS (former Relax), and the RPN result and analysis were given.

c) Combining with the experience and the result of risk assessment, certain analysis and suggestion were given. And the result shows that student athlete need further awareness on injury and treatment.

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