

Safety Performance Factor

Naray Venkataraman

M+W Zander (Shanghai) Co. Ltd., Shanghai, China

Workplace safety performance is computed using frequency rate (FR) and severity rate (SR). Only work time lost due to occupational incidents that need to be reported is counted. FR and SR are the 2 most important safety performance indicators that are applied universally; however, calculations differ from country to country. All injuries and time lost should be considered while calculating safety performance. The extent of severity does not matter as every incident is counted. So, a new factor has to be defined; it should be based on the hours or days lost due to each occupational incident, irrespective of its severity. The new safety performance factor is defined as the average human-hour unit lost due to occupational accidents/incidents, including fatalities, first-aid incidents, bruises and cuts. The formula is simple and easy to apply.

frequency rate severity rate accident human-hours

1. INTRODUCTION

The strength and success of any company lies in the effective management of productivity, quality, safety, health and the environment, in addition to marketing and finance. The environment is governed by outdoor/external factors while safety and health are governed by indoor/internal considerations. Commitment towards employees' safety and health is well demonstrated by companies' safety performance.

2. BACKGROUND

Effective risk control is founded on an effective health and safety management system. To achieve an outcome of no injuries or work-related ill health, and to satisfy stakeholders, health and safety risks need to be controlled. Most countries exclude road, air and sea accidents from their definition of occupational accidents/incidents; they also exclude self-employment ones, although some countries recognize self-employment accidents/incidents as occupational in terms of reporting and investigation.

There are many parameters that can be used to benchmark safety performance at the workplace, e.g., the number of safety training courses conducted, percentage of staff trained in safety, the number of safety inspections and percentage of legal compliance. There are other occupational safety and health performance measurements based on personal safety behavior and many more. Two prominent safety performance indicators have been used worldwide for industries, factories and other workplaces. They are frequency rate (FR) and severity rate (SR).

The International Labour Office [1] classifies occupational accident as follows: (a) total number of victims (accidents resulting in death or non-fatal injuries resulting in incapacity for work of at least 3 consecutive days, excluding the day of the accident); (b) total days lost, including the first 3 days, for nonfatal injuries.

According to section 51 of chapter 104 of the Factories Act of the Ministry of Manpower, Singapore (MOM) [2] an accident (a) causes loss of life to a person employed in the factory; (b) disables any such person for more than 3 days from earning full wages at the work at which he/she was employed; (c) causes any injury to any such

person which requires such person to be detained in a hospital for at least 24 hrs for observation or treatment.

An ordinance/regulation on incident reporting in China [3] categorizes incidents in terms of casualties and direct economic loss as follows: (a) extremely significant incidents are those resulting in the death of over 30 people, serious injury of over 100 people or direct economic loss of over 100 million CNY (~9 million EUR¹ or ~15 million USD²); (b) significant incidents are those resulting in the death of over 10 but fewer than 30 people, serious injury of over 50 but fewer than 100 people or direct economic loss of over 50 but less than 100 million CNY; (c) relatively significant incidents are those resulting in the death of over 3 but fewer than 10 people, serious injury of over 10 but fewer than 50 people or direct economic loss of over 10 but less than 50 million CNY; and (d) common incidents are those resulting in the death of fewer than 3 people, major injury of fewer than 10 people or direct economic loss of less than 10 million CNY.

Thus, there are different ways accidents are classified and interpreted. The calculation of FR and SR is based on the number of hours the employees had worked in the company over a particular period of time—usually this is one year. Some of the typical problems encountered while computing FR and SR follow.

- The exact human-hours calculation is very difficult, especially for organizations with a large employee base, as employees' overtime and leave are to be tracked and counted.
- Only reportable accidents are considered in the calculations. This means an accident involving a certain number of human-days lost is not considered in the computation of FR and SR.
- A company with large manpower base will tend to have lower FR and SR.
- These methods of calculating safety performance do not include dangerous occurrences (i.e., those incidents where there is human injury but no property loss).

3. OBJECTIVE

The method of calculating FR and SR varies from country to country. Further, in all those calculations, minor injuries or first-aid incidents involving few human-hours lost are not considered.

The objective of this paper is to devise a formula which can be applied universally, taking into account all the human-hours lost and to benchmark it within industrial sectors or on a national level. Further, to benchmark occupational safety and health management between workplaces and even among countries, a universal safety performance factor (SPF) or indicator is required.

4. METHODS

Fatalities and serious injuries are normally reported. To derive a universally accepted formula, it is important to understand the present (traditional) method of calculating FR and SR in various countries. Following are sample calculations.

4.1. Singapore

Singapore's Ministry of Manpower [2] defines FR as the number of accidents per one million human-hours worked (i.e., $FR = \text{number of industrial accidents reported per number of human-hours worked} \times 1\,000\,000$). SR is the number of industrial human-days lost per one million human-hours worked (i.e., $SR = \text{number of reported human-days lost} \times 1\,000\,000 / \text{number of human-hours worked}$).

4.2. USA

The U.S. Occupational Safety and Health Administration [4] defines incidence rate as the number of injuries/illnesses $\times 200\,000 / \text{employee-hours worked}$, where 200 000 represents the equivalent of 100 employees working for 40 hrs per week, 50 weeks per year. SR is the total

¹ 10.83 CNY = 1 EUR

² 6.85 CNY = 1 USD

number of lost workdays per year $\times$ 200000 work hrs/number of workers in a job (or a department) $\times$ 2000 hrs. Incidence rate is usually expressed as the number of cases per 100 workers per year.

4.3. Korea

The Korea Occupational Safety and Health Agency [5] defines accident rate as the number of workers covered by the industrial accident compensation insurance act $\times$ 100, fatality rate as the number of workers covered by the industrial accident compensation insurance act $\times$ 10000, morbidity rate as the number of workers covered by the industrial accident compensation insurance act $\times$ 1000 and SR as (work days lost/annual hours worked) $\times$ 1000.

4.4. Japan

The Japan Industrial Safety and Health Administration [6] defines an occupational accident as death, injury or disease suffered by a worker due to causes attributable to buildings, equipment, raw materials, gases, vapors, dust and other phenomenon related to work or as a result of a worker's conduct while he/she is at work. Accidents while commuting to and from work are not included. Further, the Administration defines a serious accident as an accident that results in three or more deaths or injuries. Annual accident rate per 1000 workers is defined as the total number of casualties in one year $\times$ 1000/average number of workers in one year. Accident frequency rate is defined as the number of deaths and injuries in occupational accidents $\times$ 1000000/aggregate number of human-hours, and accident severity as the number of workdays lost rate $\times$ 1000000/aggregate number of human-hours. Further, the number of workdays lost is computed based on 300 work days per year.

4.5. UK

The UK's Health and Safety Executive [7] defines lost time accidents as those that result in more than one day of lost time and FR is based

on a 12-month rolling period and is calculated per 100000 hrs worked.

4.6. SPF

After analyzing the traditional method of calculating FR and SR, a new definition for SPF is devised:

$$\text{SPF} = \frac{\text{total man - hours lost}}{\text{total number of incidents}}.$$

5. RESULTS

Statistical data to compare with the formula in section 4.6. could not be obtained, as obtaining that information from the industries was practically impossible. Hence, realistic theoretical examples were used to test the hypothesis.

If a company has zero FR and SR that does not mean that it is absolutely safe and no incidents have taken place. Let us consider a company that had no accidents as defined by Singapore's Ministry of Manpower and had many incidents/accidents and each incident involved employees having fewer than 3 days of medical leave due to occupational injuries. Technically FR and SR will be zero. When the corporate world is considering total safety culture, it is important to report all occupational accidents, including first-aid incidents, so long as there are human-hours lost by a company.

There are only two main elements that are to be considered while calculating safety performance: the number of incidents and the total number of lost human-hours. Even if an employee has a minor injury resulting in a one-hour rest, it should be considered. The extent of severity does not matter as every incident is counted. So, a new factor has to be defined; it should be based on the hours or days lost as a result of each occupational incident, irrespective of how severe it may be. The new SPF is defined as the average human-hour unit lost due to occupational accidents/incidents, including fatalities, first-aid incidents, bruises and cuts.

When calculating SPF, it is to be noted that an incident leading to death should be translated into an equivalent number of lost human-hours.

Human-hours lost due to death are calculated as the company's retirement age less the employee's present age, and the resulting value is converted into human-hours. If there is more than one fatality, the individual human-hours lost should be added. The same applies to other injuries including permanent disabilities. For property damage, the equivalent lost time can be calculated on the basis of time of restoration (which begins from the date of loss or damage and ends when the property is repaired, replaced or rebuilt).

6. AN EXAMPLE OF TRADITIONAL FR AND SR VERSUS SPF CALCULATIONS

Company A has 620 employees, each working 42 hrs per week. There were seven incidents (including first-aid ones) with 70 hrs lost, out of which two were reportable accidents (56 hrs or 7 human-days lost). Company B has 1200 employees, each working 42 hrs per week. There were 10 incidents (including first-aid ones) with 120 hrs lost, out of which one reportable accident resulted in more than 3 days of medical leave. If FR and SR are calculated for the two companies, it appears that company B is better. If SPF is calculated, company A is much safer than company B (Table 1).

Calculations based on SPF are simple and realistic, relevant and measurable. They account for all incidents, irrespective of the type of injury, the extent of property loss or the type of incident, and include those that are currently unreported (e.g., first-aid incidents); can be understood by a lay person; are true indicators of performance; are reliable, providing the same results when done by different people; provide sufficiently, but not excessively so, accurate information; include all occupational incidents/accidents; allow employers to have greater accountability for all occupational incidents; and eliminate the need to calculate human-hours worked by all the employees in the company.

The rationale for calculating SPF is that any injury to the employee is painful irrespective of its severity; greater (reportable) or lesser severity in terms of days lost should not be a yardstick for determining the company's safety; many first-aid or minor incidents are much more dangerous than no major reportable accidents; in a true safety culture, all injuries and time lost should be counted; and in times when economic conditions are worsening, there will be fewer workers and with workers' behavior always changing, the number of occupational injuries may increase.

TABLE 1. A Comparison of Frequency Rate (FR), Severity Rate (SR) and Safety Performance Factor (SPF)

Description	Company A	Company B	Remarks
Traditional			
FR*	$2 \bullet 1000000 / (42 \bullet 620 \bullet 52) = 1.47$	$1 \bullet 1000000 / (42 \bullet 1200 \bullet 52) = 0.38$	company B is better, with lower SR and FR
SR*	$7 \bullet 1000000 / (42 \bullet 620 \bullet 52) = 5.20$	$3 \bullet 1000000 / (42 \bullet 1200 \bullet 52) = 1.15$	
New			
SPF	$70 / 7 = 10$	$120 / 10 = 12$	company A is better

Notes. *— based on Singapore's Ministry of Manpower's definition of FR and SR [2].

7. DISCUSSION

To obtain the best SPF results, all incidents should be reported. This poses a great challenge to industries and national safety organizations. With the new SPF, the trend can be achieved more realistically and hence be able to influence management towards positive safety culture.

8. CONCLUSION

Reliance on traditional calculations of FR and SR is insufficient, especially with corporate governance and behavior-based safety gaining importance. Sooner or later, companies will be required to report safety performance, just like listed companies are willing to report

environmental performance. Every occupational injury reflects the employees' and the management's safety attitudes and behavior. The major challenge will, however, be the mechanism to make all incidents reportable and calculated. Thus, a capacity building exercise might be required on incident reporting and performance benchmarking. This has to be done on the organizational level as well as the country level.

Calculating SPF—lost time per number of incidents—is a reliable and simple tool, which clearly spells out the company's safety culture and performance. This formula is easy to calculate and does not depend on the number of employees. However, reporting accidents has to continue. The SPR is only a guide to computing a company's safety performance and to benchmarking it against any industrial sectors or national or international organizations.

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