Investigation Of Risks, Incidents and Injuries: Development of A Report Form and Model

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Abstract

English:

A report form was developed to help collect information in companies about causes of risk, incidents, and injuries. A review of the different models available for the study of risks, incidents, and injuries reveals that they lack some of the points that could be considered most relevant for a good investigation. Therefore a new model for the investigation of risks, incidents, and injuries needed to be elaborated, and this paper will propose and delineate such.

If one's objective is to continue improving results in matters of safety within a company, it is necessary to study the role played by incidents in these results. So, not only is the study of incidents necessary to improve safety, but it is important that the three factors of incidents, risks, and injuries must be considered simultaneously within the workplace.

Another basic factor in the effort to improve safety results is to determine the causes of risks, incidents and injuries. These causes must be perfectly defined, such that, once the information from any study has been compiled, they can be tested and the importance of each one determined in order to centre future efforts on prevention of the most important causes.

Spanish:

Una encuesta, plantilla o forma de informe para reportar se desarrolló para recolectar información de compañías o lugares de empleo sobre el riesgo, incidentes y accidentes. Se revisaron los diferentes modelos que existen para riesgo, incidencia y accidentes, se determinó que los modelos existentes carecen de ciertos puntos que deben ser considerados importantes para realizar un buen estudio de investigación. Por esto, un nuevo modelo para la investigación de riesgos, incidentes y accidentes necesita ser elaborado, este informe propone y examina un nuevo modelo.

Si el objetivo es continuar mejorando los resultados en cuanto a seguridad en compañías, es necesario estudiar el papel que juegan los eventos en estos casos. Por lo que no solamente es necesario estudiar los incidentes para mejorar la seguridad, pero es importante que los tres factores de los incidentes, riesgos y accidentes sean considerados simultáneamente dentro del lugar de trabajo.

Otro factor básico en el esfuerzo para mejorar la seguridad de los resultados es determinar las causas de los riesgos, incidente y accidentes. Estas causas deben ser delineadas perfectamente, una vez la información de cualquier estudio haya sido compilada, pueden ser examinadas y la importancia de cada una determinada para delinear futuros esfuerzos en la prevención de las causas más significativas.

Keywords: Injury Control & Prevention; Risks; Models

The investigation of Incidents

Retrospectively, accidents are evidence of dysfunction in our existing safety programs. However, currently we tend to put more emphasis on the investigation of incidents, including those that have not led to injuries, as a tool for improvement within a company.

One of the first people to realize the need for investigation of injuries (at this time most people preferred the word "accident") and incidents was Bird, President of the International Institute for Loss Control. According to him, companies need a written accident investigation policy and a good accident investigation program regardless of the frequency with which accidents may occur. In the case of newly formed companies or companies which wish to improve their accident rates, accident investigation is a way of getting to know the company's problems, while more stable companies, perhaps with very good rates, need an incident investigation program to be prepared for infrequent accidents. Furthermore, the existence of a good program is an indication of safety management.

For Bird (1975), all accidents (the word he uses) must be investigated, whether they result in injury or merely cause economic losses. One must not forget that incidents may end up as injuries; it is only a question of luck. The fact is that incidents reflect that something is not working quite as it should, and as a result, needs to be fully investigated. This investigation must be taken as an opportunity to examine and correct problems before a serious injury can occur.

Along the same lines, the Association for Prevention of Accidents (APA) in Spain (1988) considers that a company wishing to avoid injuries, reduce losses, and increase efficiency must systematically examine all the injuries and incidents that have occurred. What is more, investigating all the causes that can lead to injuries where there has been no injury will allow eradication of all the possible sources of risk in industry; both for situations where there is injury and where there is not.

Jacobs and Nieburg (1989, 1992) recommend that all serious incidents be thoroughly investigated, although they differ from the aforementioned authors in the intensity of the investigation, pointing to the time required by personnel and their corresponding absence from other activities within the company. As a possible solution, they propose analyzing the extension and need for such an investigation.

With these antecedents, the 1990s saw the rise of a current of thought which defended the joint study of injuries and incidents. Its greatest exponents were authors such as Manzanedo (1994), Senecal and Burke (1994), Krause and Russell (1994), National Safety Council (1995, 1997), Minter (1995), Kirkwood (1997), Goldberg (1997), and Lake (1998), some of whom formulated models for incident reporting and even for incident analysis.

A specific case is that of Manzanedo (1994) who states that the trend in the current science of prevention takes into account even the smallest industrial incident, even though it causes negligible damage. Similarly, Senecal and Burke (1994) propose a method for accident study that can also be applied to incidents, believing that these must form an integral part of the measure of any safety system.

It can be seen how traditional safety programs, which provide a measure of injury rates based solely on the use of injury investigation, have progressed to a new analytical perspective which upholds that incidents may provide a more adequate measure of the effectiveness of a safety program, while recording and investigating incidents that may be critical to the prevention of injuries. The company that makes a commitment to safety must begin to investigate incidents. This implies, above all, adequate training of its employees and the firm belief that incidents are, if not more important, then equally important to accidents. The fundamental point underlying this incident investigation is the answer to the question "What could have happened?" rather than "What happened?" (Smith, 1994).

Krause and Russell (1994) define an injury situation and incident in such a way that they recognize that although injury situations and incidents may at first seem different, they are in fact the same and should therefore be studied in a similar way. Likewise, the National Safety Council (1995, 1997) point out that an incident, which could potentially result in personal injury or damage to property, must be investigated in the same way as accidents. The reasons put forward for investigating incidents are that:

- By investigating the cause of an incident, one can prevent future injuries and so, serious injuries, damage to property or both.
- The rest of the workers would be alert to the possible risks.
- The company can take corrective action to eliminate or control the cause of incidents.

Among the twelve attributes that the best safety practices must possess, based on those carried out by Du Pont, Minter (1995) points to the investigation of incidents. The twelve criteria are related to the following areas:

- The proven commitment of management.
- Integration of safety and health activities within business plans.
- Varied and regular communication.
- Work processes and systems must reflect orientation towards teamwork.
- Detailed attention to the discipline of operations.
- Varied and regular audits.
- All incidents must be investigated and corrections put into practice to avoid recurrence.
- Permanent training.
- Carry out continuous measures.
- Visible recognition and rewards.
- Personal responsibilities.
- Professionals in safety, health and the environment must be integral members of business teams.

The same author states that the pillars for a successful safety organization are:

- The synergies between all members that may help problem solving.
- All members of the organization are given the opportunity to develop and draw up safety and health programs on their own.

- Respect the dignity of others.
- Addition of value to the organization.
- Continuous improvement.
- The program must be geared towards the client.
- Excellence, which will be achieved if all the previous steps have really been performed.

Having justified the need for investigation of incidents, one should deal with other questions that justify incident investigation. Just as Goldberg (1997) points out, the more injuries that are documented, the more problems can be investigated and solutions found; at the same time, the more problems are solved, the safer and less costly operations will be. Kirkwood (1997) coincides with this idea, but contributes a new vision or advantage of carrying out incident investigation. As the author describes, it consists of learning from an incident, but without the stress, publicity or fear of responsibility which could have resulted in the case of personal injury. As a consequence, the investigation of injury situations goes beyond mere reports, since the basic causes must be sought, such as procedures and practices that workers cannot perform.

However, it does not suffice to put in writing the need to deal with injury situations and incidents in the same way. In addition, the investigation must be carried out in a practical fashion. Thus, Lake (1998) describes how to carry out an investigation and the different steps to follow for incidents. Using a similar pyramid to that of Heinrich, he justifies the investigation of incidents saying that this provides more opportunities to identify or prevent an injury before it happens.

We must also underline that it is not only in industry where the importance of a similar study of injury situations and incidents is reflected. In the construction sector, accident rates are worse and implementation of safety programs is more complicated. Yet here too, the importance of investigating incidents is reflected. Henderson (2000) says that in this sector the compilation of incidents and taking of measures to avoid their recurrence may lead to injuries being prevented.

Determination and Classification of Causal Factors

The investigation of injuries, incidents, and even risks gives a set of causal factors that need to be grouped and classified if they are to be studied. It is true that, depending on the criteria used, classifications of causal factors can be almost infinite.

In order to clarify this situation, we will discuss the classifications put forward by Baselga (1984) and Bird (1975), which can be regarded as the basis of later ones. Then we will look at other taxonomies that introduce slight variations to the first, i.e., those proposed by Jacobs and Nieburg (1992), Krause and Russell (1994), Gothard and Wixson (1994), and Niven (1999).

We will also explain classifications carried out by other authors, such as Turner (1978), Wright (1986), Wagenaar and Groeneweg (1987), Shrivastava's Bhopal (1987), Dawson et al. (1991), Hurst et al. (1991), Embrey (1992), Hofmann and Stetzer (1996), Kamp and Krause (1997), and Brown, Willis, and Prussia (2000), who use organizational type factors as their criteria. Finally, Adnett and Dawson (1998), who established a classification based on macroeconomic aspects, will be discussed.

According to Baselga (1984), the cause of a work injury is any agent, event or circumstance that intervenes in the genesis or facilitates the development of a work injury. This author establishes the following classification:

1. By Natural Factor, that is, according to their nature, causes are normally divided into:
   - Technical Causal Factors: those resulting from the characteristics of installations and equipment, or of pre-established work methods and systems (Fernández, Domingo, & Manchado, 1976). These are sometimes identified as unsafe or dangerous material conditions or also as "technical faults".
   - Human Causal Factors: those human actions or omissions that originate, cause, and explain situations of potential hazard and danger and which give rise to accidents and consequences. They are also known as "dangerous acts or human errors". For Fernández, Domingo, and Manchado (1976), these causes are those arising from the action of people, both in reference to their attitude and to their aptitude.

     In any injury situation there is either a technical fault or a human error, while behind any technical fault there is a human action or omission that explains it. However, the control of human factors is considerably more difficult than the control of technical factors. The modern view of safety is based on the re-evaluation of the human factor, while maintaining efficient priority control over technical causal factors (Baselga 1984).
2. By Preventive Efficiency, that is, by consideration of the probability of avoiding similar events. The following can be considered:
   - Principal Causes. Those whose incidence on the accident is such that their sole removal would, in all probability, have avoided it.

- Second Order Causes. When their elimination does not guarantee that similar cases will not be repeated.

3. By Chronological Phase, that is, according to the chronological scheme of the development of an injury situation, one can differentiate between:
   - Basic or Primary Causes. Those that originate or permit the appearance of the hazard; also known as the causes of the risk by Fernández, Domingo, and Manchado (1976) or primary risks in the terminology of Hammer (1972).
   - Secondary Causes. Those that permit the potential risk to trigger an injury situation, or causes of the event according to Fernández, Domingo, and Manchado (1976).
   - Tertiary Causes. Those that result in destructive consequences (damage and injury); known as causes of the consequences by Fernández, Domingo, and Manchado (1976).

Bird (1975) proposes a division of the causes into Basic and Immediate. The Immediate causes are the specific motives that bring the accident about, while Basic causes are more general in nature and are intrinsic to the very organization of the company. The Immediate causes are normally observable and can be felt and usually include "unsafe acts" and "unsafe conditions".

In some situations, the terms "substandard acts" and "substandard conditions" are used. This line of thought has the following advantages:

- It relates practices and conditions with a standard, thus creating a base for future measures, evaluation and corrections.
- It reduces the accusatory stigma of the concept of "unsafe act".
- It broadens the field of interest by incorporating safety, quality, production and cost control.

The most common immediate causes relative to substandard acts and substandard conditions are

- For unsafe acts
  - Working without authorization.
  - Working in unsafe conditions or at unsafe speeds.
  - Failing to give warning or provide signals.
  - Cutting off safety mechanisms.
  - Using defective equipment.
  - Using equipment in an unsafe way
  - Adopting unsafe positions.
  - Repairing or assembling dangerous equipment.
  - Not using adequate protection.
  - Jokes and games.
- For unsafe conditions
  - Inadequate shelter and protection.
  - Inadequate warning or attention systems.
  - Danger of fire and explosions.
  - Unexpected dangerous movements.
  - Lack of order and cleanliness.
  - Danger of projected objects.
  - Lack of space.
  - Dangerous environmental conditions.
  - Dangerous storage.
  - Unsafe equipment.
  - Inadequate lighting, dazzling lights.
  - Noise.
  - Dangerous or inadequate personal clothing.

Given that some basic causes help to explain why people commit substandard acts they are more difficult to discover, requiring thorough investigation for their detection and control. Logically, they also contribute to explaining why substandard conditions exist, such that, if adequate standards do not exist or if the administration does not enforce them, then inadequate equipment and materials that represent a risk may be acquired.

In Niven's study (1999) of hospitals, where he makes a compilation of incidents, Basic Causes are identified as those which are reasonably identified and which management can control. According to this approach, the basic causes can be divided into personal factors and work factors, the following being the most common:

- Personal factors:
  - Lack of knowledge, capacity, or aptitude.
  - Lack of adequate motivation.
  - Attempt to save time, effort or discomfort.
  - Existence of physical or mental problems.
  - Expression of independence, hostility, attention of the group, etc.
- Work factors:
  - Inadequate norms.
  - Inadequate design or maintenance.
  - Inadequate purchasing norms.
  - Incorrect work habits.
  - Normal use and wear.
  - Abnormal use.

Bird's investigation (1975) showed the great importance of the human factor, since of every one hundred accidents, eighty-five were due to unsafe practices and only one occurred as a result of unsafe conditions; the remaining fourteen resulted from a combination of the two causes. People are therefore responsible for almost 100% of injuries, whether this is because of unsafe practices or because of causing unsafe conditions.

However, the current view of safety is directed towards searching for the basic and remote causes, rather than for the immediate causes that trigger accidents (Baselga 1984). Continuous Quality Improvement (CQI) has enabled us to change the focus from isolating and blaming the individual and instead examine the entire process. The focus is now on process rather than the individual. The work of Deming (1964, 1986, 1952) has contributed to the statistical analyses of workplace conditions and improvements. For Jacobs and Nieburg (1992), the immediate causes only involve the employee, while it is the basic causes that create an environment that permits the presence of immediate causes. Now, the elimination of these basic causes is difficult because it means making changes in the management of safety. Also, these authors point out that carelessness, bad judgement, bad attitudes, etc., should not be considered generators of incidents. The following would rather be examples of basic causes:

- Bad training.
- Lack of any obligation to follow the rules.
- Low safety morale.
- Poor maintenance.
- Overcrowded work area.

Coinciding with other investigators, we consider an injury situation as a series of linked events or causes, such that the immediate causes would be the final link in a chain of events that necessarily begins with a deficiency in the safety management system. In other words, the basic causes favor an environment that permits the existence of immediate causes.

The experience of the Port Neches company, in Texas, where a study of injuries was carried out using a method similar to the tree of causes, gave the following classification of basic causes grouped in four categories:

- Difficulty of human development.
- Difficulty of the team.
- Natural phenomena, sabotage.
- Others.

From among these groups, the root causes are later determined, which can in turn be divided into more specific groups. These root causes are included in some of the following categories:

- Procedures.
- Training.
- Quality Control.
- Communications.
- Management System.
- Human Engineering.
- Supervision.

In the application of a process of continuous quality improvement in a hospital, Gothard and Wixson (1994) distinguish between common causes, as the sum of all lesser causes when combined randomly produce a variation, and special causes, where the variation is usually intermittent. When there are no special causes, and only common causes are intervening in the process, then the process is said to be under control. This study talks about the need for sophisticated tools that permit effective analysis to adequately identify both the basic and the special causes and, thus, determine the areas of interest.

Using quality tools in assessing safety are mentioned by most investigators. Also modern risk analysis techniques have contributed greatly to achieving the scientific-experimental objectivity required through probabilistic methods in the context of the theory of systems, using Boolean algebraic techniques such as the Tree of Errors, Safety tables or AMFE (Baselga 1984).

Krause and Russell (1994) confirm that risky behavior is commonly present in most injury situations where people are injured. When an injury related to behaviour occurs, it is highly likely that this same attitude has not caused injury previously. Hence, risky behavior manifested regularly, becomes a part of the system (common cause). Therefore, it is these causes which must be identified, more so than the special ones, because, once found, they do not require reactions, such as disciplining, new regulations, etc., but fundamentally, an improvement of the system.

Several recent publications on injury investigation point to the increasing importance of the role of organizational factors, as antecedents to the sequence of an injury. Amongst these studies are those of Turner (1978, 1995), Wright (1986), Wagenaar and Groeneweg (1987), Shrivastava´s Bhopal (1987), Dawson et al. (1991), Hurst et al. (1991), Embrey (1992), Hofmann and Stetzer (1996), Kamp and Krause (1997), and Brown, Willis, and Prussia (2000).

Wright (1986), for example, had already investigated the relevance of organizational factors as the genesis of the sequence of the injury situation, identifying the following three areas:

- Although an injury must be considered normal in a company that uses potentially dangerous processes, there are often no procedures set down in the case of injury.
- The existence and influence is detected in the company of considerable pressure to complete tasks as quickly as possible.
- Communication in the area of safety is deficient.

Wagenaar and Groeneweg (1987) in a study in which they review one hundred injury situations at sea to determine the types of human error, also detect organizational factors such as information processes, and social pressure, concluding that:

- Errors in information processes occur most frequently in high stress situation, which is to be expected.
- Social pressure is more influential for the development of work than formal rules.

Turner (1978) has made clear in studies of worksite disasters that communication problems contribute to injury causation. He argues that the events that cause disasters accumulate because they are ignored or misinterpreted, as the result of habits or routine, false beliefs, inadequate communication, thoughtless norms or instructions and unjustified optimism. This author, in a later work, emphasizes that safety practices require the intervention of management and all the work force. Managers must create a positive safety culture and an open atmosphere of learning in which errors and incidents can be openly discussed without blame or recrimination (Turner, 1995).

At a more organizational level, Shrivastava´s Bhopal (1987) states that injuries are the consequence of the following three factors:

- Human beings.
- Organizations.
- Technology used.

Other authors have also pointed to the above factors. Embrey (1992), for example, identified key factors of organization that may have an influence on the development of safety: the balance between safety and production, time pressure, communication and co-ordination systems and the safety culture. Dawson et al. (1991) similarly concluded that the channels of communication and the safety culture are two key factors that may influence the understanding of technical and social systems of organization by the worker. Hurst et al. (1991) proposed similar factors.

Hofmann and Stetzer (1996) analyzed the influence of pressure of work, communication or co-ordination and the social climate on the development of safety in an organization. They distinguish between individual and group variables and their relation with unsafe behavior and acts, respectively. Specifically, they identified three group factors: processes, the climate of safety and the intention to be closer to other group members, and an individual factor, the perception of having an excessive workload.

Hofmann and Stetzer (1996) investigated a chemical company with 21 teams and 222 individuals, and identified more than 250 unsafe conditions and behaviors. Faced with such a large number of possibilities, they were grouped in the following six categories:

- Incorrect use of tools.
- Improper use of work strategies that entail risk to oneself.
- Not wearing personal protection.
- Dangerous storage of tools.
- Inadequate storage of other elements.
- Improper use of work strategies with risk for other workers.
- The most relevant results of this study can be summarized in the following points:
- Individual perceptions of having an excessive workload are positively related with unsafe behavior.
- The relation between the functioning of groups and behavior relative to safety depends on the tendency of their members towards safety activities.
- The most efficient teams have fewer injuries.
- The greater the perception of a climate of safety, the less unsafe behavior there is.
- Teams with a greater perception of the climate of safety have fewer injuries.

In short, the overall result of Hofmann and Stetzer's study (1996) was the affirmation that excessive workload, group processes and the climate of safety are each related with unsafe behavior. What is more, while the climate of safety and unsafe behavior are related with current accidents, group processes are only marginally related to this.

Equally, other authors have analyzed the influence of these or similar factors, since, despite the popular belief that the unsafe acts of workers are the primary cause of workplace accidents, a new perspective, which includes the influence of social and operational systems, needs to be tested. Thus, Brown, Willis, and Prussia (2000) show that risks in safety, the safety culture, and the pressure on production are related to the efficiency of safety and the adoption of attitudes, which are translated into safe or unsafe behavior at work. In the study, carried out amongst workers in a metal industry, the authors used a questionnaire on social, technical, and personal factors relative to safe behavior at work.

Kamp and Krause (1997) uphold that there are very few situations in safety (and in life) in which different people behave in the same way. Although on some occasions, people behave differently and this variability is due to differences between people, such as abilities, attitudes, values, beliefs, emotional states, or the characteristics of personality itself. For example, when a company establishes new safety procedures, although most employees wish to comply with it, some will fail to do so for the following reasons:

- Not knowing how to follow the process (Ability)
- Considering it is not necessary (Attitude)
- Believing they will not be discovered (Belief)
- Forgetting it because of stress (Emotional state)
- Taking shortcuts to save time and effort (Personality)

Therefore, recognizing that most human behavior is influenced by both personal and situational factors has important implications when dedicating the effort necessary to improve safe behavior in the work place (Kamp and Krause, 1997). Nowadays, the human factor is considered so important that safety techniques and program centered on the study of behavior are appearing.

Finally, and without going into detail, there are many studies as to how macroeconomic factors may influence the occurrence of injuries. This is the aim of the works of Adnett and Dawson (1998), in which factors related with state regulation, market failings, the impact of institutional, and macroeconomic forces, amongst others, intervene.

Report Sheets for the Investigation of Risks, Incidents and Injuries

Once the need to study incidents has been recognized, and taking into account the obligation to investigate risks and injuries, the possibility of studying the three (risks, incidents, and injuries) jointly should be considered. This approach would make the most of the vast quantity of information contributed by the high number of risks and incidents, and the good information contributed by injuries, since an injury is a fait accompli that provides completely tested information.

There is no universally or obligatory report form for this joint study of risks, incidents, and accidents, nor has its minimum content or structure been defined or how the information collected should be treated. The report form to be used must simply be adjusted to each company (type, structure, organisation, etc) to enable and aid it in fulfilling its legal obligations. This is the point that Baselga (1984) makes: at company level, the report forms used and the people responsible for filling them in must be in accordance with the organization of each company.

The minimum conditions that any report form must fulfill are:

- It must be simple, such that it is easy to use.
- It must be specific, to ease management of the data contained within.
- It must be clear, such that the analyst has no doubts or needs to make his own interpretations while filling it in.

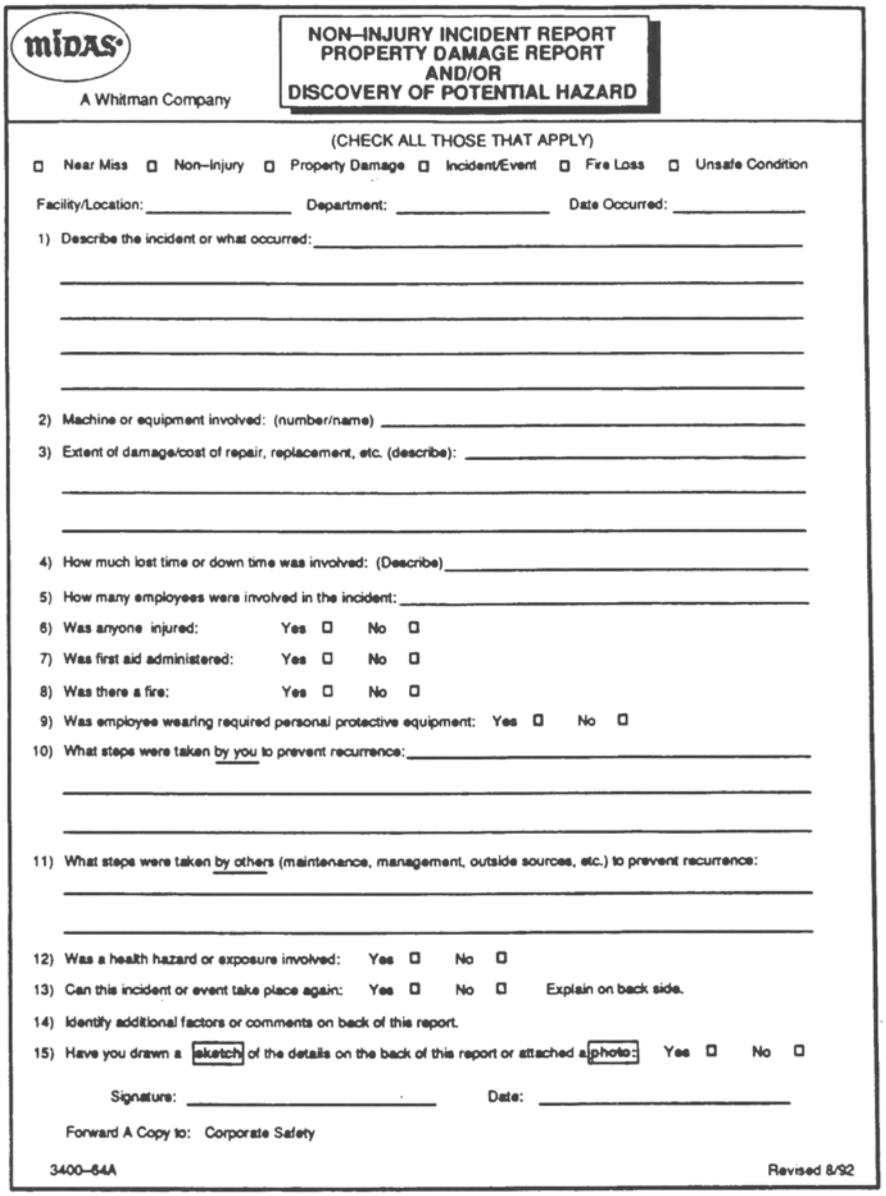
As general guidance for the elaboration of a report form, which as we have explained earlier, we must highlight:

1. All areas of data necessary for the correct management of the risk, incident or accident must be taken into consideration and structured, for example:
    - Identification of the person involved.
    - Place where the event occurred.
    - The agent responsible
    - Among others.
2. It must allow and aid an in-depth analysis of cause by the investigator. For this, it is useful to include a list of causes of different types (organizational, material, personal, etc.) that the analyst can consult and evaluate. In this aspect Cortés (1997) proposes collecting the following information concerning the causes detected:
    - Origin of the incident (Technical or Human).
    - Origin of any injury sustained (Technical or Human).
3. The people responsible for the areas in the document must sign it, showing their conformity with its contents.
4. It must incorporate proposals for corrective measures and, if needs be, indicate the people responsible and the deadline for their execution. Likewise, it must also incorporate the control of the goodness and suitability of the measures applied (Cortés, 1997).
5. Data may be included which permit analysis of the "estimated costs" of an injury, incorporating together with the data of the "direct costs", "hidden or indirect costs".
6. It should allow incorporation of a series of conclusions as to the event, both regarding legal infringements and safety reports (Cortés 1997).
7. There are several other authors who, like Cortés(1977), express the need to include in this report graphic material (photos, plans, schemes, etc) which are considered necessary for a better understanding both of the incident itself and of the corrective measures proposed.
8. In some cases there is a proposal for risk assessment in order to give priority to corrective actions (Cortés 1997).

In summary, there do exist several report forms which attempt to compile the information necessary for a joint study of risks, incidents and accidents, for example, the report forms of the NTP (Technical Norm of Prevention) 442 (1997), National Safety Council (1997), Baselga (1984), Midas (1993), Jacobs and Nieburg (1992) or the Association for Prevention of Accidents (APA) (1988). Figure 1 shows an example of the Midas (1993) report form in which one can see its extreme simplicity and the fact that it contains a high percentage of open questions, both of which markedly complicate the later work of statistical treatment of the data obtained.

Model for the investigation of Risks, Incidents and Accidents

The Midas report form (see Figure 1) and the rest of the report forms in existence for the investigation of risks, incidents, and injuries, suffer from the same problems, the most serious of which is the scant treatment of the causes that generate the events.



midas

A Whitman Company

NON–INJURY INCIDENT REPORT
PROPERTY DAMAGE REPORT
AND/OR
DISCOVERY OF POTENTIAL HAZARD

(CHECK ALL THOSE THAT APPLY)

☐ Near Miss ☐ Non–Injury ☐ Property Damage ☐ Incident/Event ☐ Fire Loss ☐ Unsafe Condition

Facility/Location: ________ Department: ________ Date Occurred: ________

1) Describe the incident or what occurred: ________

2) Machine or equipment involved: (number/name) ________

3) Extent of damage/cost of repair, replacement, etc. (describe): ________

4) How much lost time or down time was involved: (Describe) ________

5) How many employees were involved in the incident: ________

6) Was anyone injured: Yes ☐ No ☐

7) Was first aid administered: Yes ☐ No ☐

8) Was there a fire: Yes ☐ No ☐

9) Was employee wearing required personal protective equipment: Yes ☐ No ☐

10) What steps were taken by you to prevent recurrence: ________

11) What steps were taken by others (maintenance, management, outside sources, etc.) to prevent recurrence: ________

12) Was a health hazard or exposure involved: Yes ☐ No ☐

13) Can this incident or event take place again: Yes ☐ No ☐ Explain on back side.

14) Identify additional factors or comments on back of this report.

15) Have you drawn a sketch of the details on the back of this report or attached a photo: Yes ☐ No ☐

Signature: ________ Date: ________

Forward A Copy to: Corporate Safety

3400–64A Revised 8/92

Figure 1. Midas Non-Injury Incident Report Form (1993)

To solve this problem, we now propose a model report form which allows for the study of risks, incidents, and injuries, and which contains a series of causes, enumerated in a precise way, so that they can be studied statistically later.

It is worth reminding one at this point that the fact of integrating in a single study, risks, incidents, and injuries arises because all injury situations are incidents which have generated injuries, while in turn, incidents are risks which have occurred. That is, the very act of carrying out an activity entails some dangers, which, once quantified, are converted into risks. Some of these risks may materialize in the form of incidents because the probability of their occurrence transforms them into faits accomplis. These incidents or consummated risks can be of two types, those that generate personal injuries and those that do not. In the former case they are then considered as injury situations, with or without absence from work.

Under these circumstances, injuries situations are also risks that have been materialised and so their study and investigation must include those in which the risk does indeed become an injury. If risk assessment assumes the probability of the event occurring, then investigating incidents is important. The same occurs with incidents which reveal risks, not only which may occur, but also which have occurred. This relationship is shown in Figure 2.

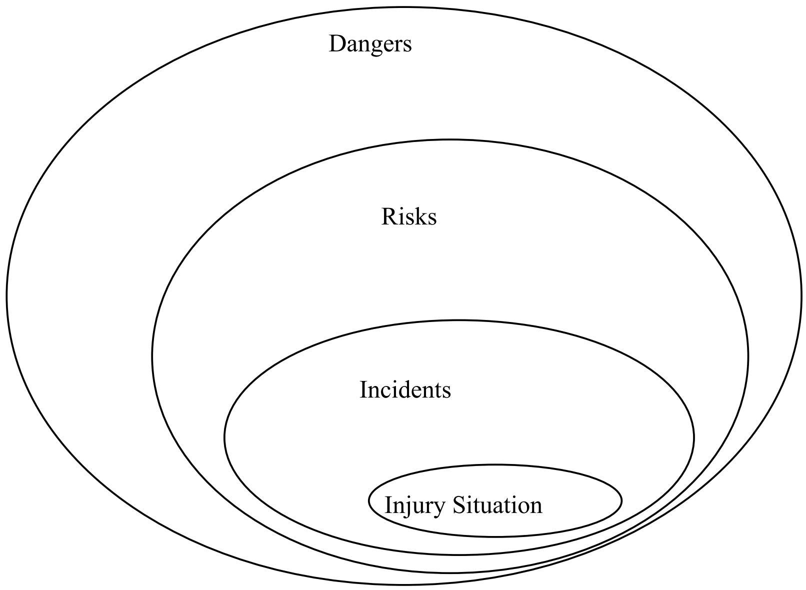


Figure 2. The process of an Injury. Source: The Authors.

These three types of events are related to each other in several ways. Initially, one of the first relations is chronological, since risks are always the first to take place, some of them being followed by incidents, some of which in turn will become injury situations. Intuitively, another relation between them has already been described, which is the existence of a ratio between the three types of event.

For the statistical study of the three phenomena mentioned previously, we aim to analyze the different causes that generate them and later carry out a relative quantification or weighting of these causes in the genesis of risks. To do this, a closed questionnaire was made up to aid selection of existing causes. This questionnaire was included in a process in which all the members of the company to be investigated took part. Despite the fact that many authors have focused on basic causes, we believe that it is not possible to analyze them without prior knowledge of the immediate causes. A classification is therefore proposed, in some ways similar to those of Baselga (1984) and of Bird (1975), with immediate causes divided into substandard acts and conditions.

In this way, the possibilities amongst the causes included in our study, bearing in mind criteria of simplicity and brevity but at the same time seeking the maximum representation and integration of all the theories developed up to the present, are:

Concerning substandard acts:

1. Use of defective equipment.
2. Incorrect use of equipment.
3. Failure in protection.
4. Improper storage.
5. Incorrect lifting of objects.

Concerning substandard conditions:

1. Defective tools, equipment or materials.
2. Inadequate or insufficient protective equipment, shelters and adequate warning systems.
3. Limited space for movement.
4. Deficient order and cleanliness in the work place.

Once the causes to be studied have been chosen, a model report form for collection of information proposed for use in a company is shown in Figure 3 (developed by us).

SAFETY OBSERVATIONS

NAME:.......................... Nº:........... SHIFT:.............

DATE: / / 2001 Nº

TYPE

1 ☐ RISK (Unsafe condition or action which may cause an accident)

2 ☐ INCIDENT (Any fact or mishap ocuring with no physical injury to the person)

3 ☐ ACCIDENT (When there is physical injury)

31 ☐ WITH SICK LEAVE → Initiate process of accident analysis

32 ☐ WITHOUT SICK LEAVE

DESCRIPTION: (Include possible consequences) ....

....

....

....

....

....

ORIGIN	REPORT	CLOSE
1 ☐ On the spot observation 2 ☐ Safety meeting 3 ☐ Programmed Safety Visit 4 ☐ Audit 5 ☐ Others	☐ ,,,,,,/,,,,,,,,,/ 2001	☐ ,,,,,,/,,,,,,,,,,/ 2001 Worker sign

TYPE OF ACTION

1 ☐ Corrected immediately

2 ☐ O. T. A. → Nº: ________________ ☐ Warn / Signal

3 ☐ Suggestion →

4 ☐ Other actions Nº: ________________ ☐ No proposal

→ PLAN OF CORRECTIVE ACTIONS ←

WHAT	WHO	WHEN

Figure 3: A model form for collecting appropriate injury potential information – Front side

CLASSIFICATION

CONDITIONS	1 ☐ Use of defective equipment
	2 ☐ Improper use of equipment
	3 ☐ Failure in protection
	4 ☐ Incorrect storage
	5 ☐ Incorrect lifting of objects
ACTS	1 ☐ Defective tools, equipment or materials
	2 ☐ Inadequate or insufficient protective equipment
	3 ☐ Limited space for movement
	4 ☐ Deficient order and clanliness in the work place

Are there other areas with a similar risk?

NO ☐ YES ☐ → WHERE?_________________________

____

DO ACTIONS PROPOSED ELIMINATE THE RISK?

NO ☐ YES ☐ → WHY?________________________

____

CLASSIFICATION OR RISKS		ACTIONS	
Value A	**Gravity of damage**	**A * B * C**	**Action**
100	Catastrophy, many deaths		
40	Disaster, several deaths	>320	Very high risk
15	Very serious, one death		Consider stop activity
7	Serious. Sick leave with aftereffects		
3	Important.Sick leave with no aftereffects		
1	Significant. No sick leave	160-320	High risk
Value B	**Gravity of damage**		Immediate countermeasures
10	Occurs frequently		
6	Very likely		
6	Uncommon but possible	70-159	Considerable risk
1	Only possible in long-term		Requires solution
0.1	Almost non-existent		
Value C	**Time of exposure to risk**		Risk existing
10	Continually	20-69	Requires attention
6	Daily, during work hours		
3	Weekly or at times		Low risk
2	Monthly	<20	Acceptable
1	Occasionally		
0.5	Hardly ever	Mark with the level of risk	

Figure 3. A model form for collecting appropriate injury potential information – Back side

We have observed that these acts and conditions are also related, where the two are a manifestation of a malfunction in the system, whether it is through the human factor or the result of material conditions. The relation between the two types of causes may be very strong, since it is a problem which becomes apparent through an act, or at other times, through conditions and even, occasionally, through the two possibilities simultaneously.

Thus, once the existence of effects or results, which are inter-dependent, has been seen, and of different causes, typified in two groups, which are in turn related to each other, all that remains is to specify their relation. In this way, two new types of union appear. The first is between the type of event occurring and the substandard acts and the second, similarly, between the type of event and material conditions. These connections will be very important because they reflect how each of the causes influences the type of event, enabling the researcher to draw important conclusions to improve the safety results.

All these ideas are grouped together in graphic form in Figure 4 that summarizes the model elaborated from this piece of research. As workers perform various work and non-work related acts and various and different conditions, they are exposed to risks. Depending upon attention to safety, safe behavior, environment condition, use of personal protective equipment, administrative controls (rules and regulations), and engineering controls, the worker will have exposure to various risks. As these risks increase or there is a reduction in safe behavior, etc., the worker will a higher probability to having a close call (incident) resulting in "near" injury and/or property damage. When conditions and/or behavior are interrupted, an injury occurs.

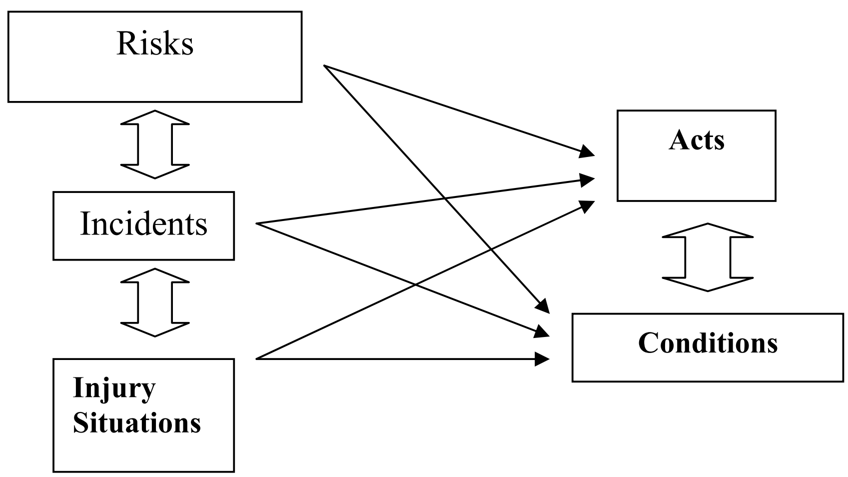


Figure 4. Model Proposed. Source: The Authors

A Study of the Model

In order to test the relations, quantifying their importance, we have studied a company in which the model report form described earlier was introduced to collect information about risks, incidents, and accidents.

The Spanish company studied belongs to the metallurgical sector and has a workforce of about 400. Despite being in such a competitive sector with high injury rates (metal), the great efforts made in the areas of Quality and Safety have enabled this rate to fall drastically in the last few years, up to the point of being almost insignificant. These improvements have affected both the areas of safety and quality, and even that of production.

Internally the company was divided into two units of production, both studied in this paper. Given the transcendence of the two units, the results can be considered as pertinent to the whole company. Other areas or departments such as finance, purchasing, maintenance, etc. were not analysed. However, for the case of the production units mentioned, the study was extended from the lowest levels to the highest, allowing for the participation of all the people involved such as workers, production line heads and managerial staff. There were thus about 350 workers directly involved.

The report form and model was quickly introduced into the company, due mainly to a highly developed company culture that favors training, participation, and communication between workers. The introduction began with the initial training of the workers and in general of all those who could become involved in the safety model and report form, explaining to them the objectives, means, and actions to be taken.

Also of great importance for the introduction of the report form and model were safety meetings, either during company time or outside company time, designed to aid collection of information. The existence of this activity and the generation of mechanisms, such as the preparation of rooms for meetings of workers, the existence of a format for suggestions (quality, productivity, etc.) aid the introduction of the model, which in some cases uses the means available for other activities, demonstrating the synergies existing between different areas and the advantages of the integration of safety in the rest of the company's functions. After this beginning and after a short period of time during which information collection commenced, the process was considered stable.

Over a two-year period, 918 safety observations were collected, distributed in 545 risks, 253 incidents, and 120 injury situations. These total observations were reached after a refinement process, which consisted of suppressing some of the observations for which the corresponding causes could not be ascertained. Their inclusion would have distorted any analysis.

It was worth noting the high degree of employee participation in the project, which even today continues to be high. Initially it was expected that as risks began to be discovered, participation would begin to fall (there being fewer risks possible), but this effect was countered by the progressive introduction of the system. We found that even new risks continue to be detected and the commitment of the participants is even greater. Given that the company has scarcely modified its processes or rotation of machinery, the appearance of new risks becomes less and less, making the high level of participation all the more significant. We believe high level of participation was largely due to the existence of a genuine preventionist culture within the company.

With the application and statistical treatment of the data obtained from the report sheets in this company, we observed that the risks, incidents, and injuries were interrelated, with a pyramidal proportion, similar to that reported by Heinrich. We can say that one can act on the elimination of some items by working on the reducing the others.

The grouping of the causes that generate risks, incidents, and injuries into acts and conditions are correct, and there is a high degree of relationship between the two groups. Likewise, the causes do not have the same degree of influence, and their relative importance in the generation of events can be quantified. For example, the existence of defective equipment, tools or materials is the major cause of accidents.

Finally, the correct introduction of the study of risks, incidents, and injuries allows for a substantial improvement in safety in the company. In fact, the injury rate in the company studied has fallen markedly since the model was introduced. A complete analysis of these data will be reported in a future paper.

Conclusions.

Perhaps the first and most important conclusion to be drawn is the need for the study of incidents, since although there may not have been any injuries sustained, the study may be a great help in improving results in safety. This study of incidents, integrated within a wider study which takes in risks and injuries, may provide much more interesting results, because of the large volume of information brought to bear, and the complementary nature of this information.

It is also important to point out the high number of causes that can affect the injury rate of a company. The determination of these causal factors, and their classification, is very important for their posterior empirical analysis in order to detect the most important causes and act on them. From the study of these causal factors there emerges a classification that can be included in any study of safety.

With the elaboration and completion of the report sheets, one can make a joint study of risks, incidents, and injuries, which in addition, includes the classification of the causes elaborated earlier. One can also ascertain the most important causes on which the company needs to act.

Through the application of this model, which also incorporates a mechanism for the quantification of the size of the risk, based on the William T. Fine model, two fundamental facts are observed: the relation between causes (acts and conditions) and the resulting events (risks, incidents, and injuries) and secondly, that not all causes have the same influence on the generation of an injury. Thus, the application of this model allows the safety technician to improve prevention management in a company by being able to detect the most influential causes in the generation of injuries.

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