

Preventing potential hazards in the development of machinery

Ivan Kuric^{1,*}, Milan Sága Jr.¹, Andrej Bencel¹, Martin Bohušík¹, Michal Bartoš¹
 University of Žilina, Faculty of Mechanical Engineering,¹
 Department of Automation and Production Systems, Slovakia¹
 ivan.kuric@fstroj.uniza.sk

Abstract: The article focuses on the definition of industrial business risks that are associated with risk management. Following the description of the risks, the article then focuses on the elimination of the hazard or the reduction of each of the two criteria that determine the risk in question, such as the severity of the damage caused by the hazard and the likelihood that the damage will occur, separately or simultaneously, are two ways to achieve the purpose of risk reduction. The article is highly relevant to the implementation and development of technical systems and equipment.

Keywords: INDUSTRY, SAFETY, HAZARD, RISK

1. Introduction

The manufacturing industry forms the backbone of many nations' economies. This is especially true for countries like Slovakia where their share of total economic output is much higher than in several other national economies. With the rise of new technologies and ways of working, traditional manufacturing is facing enormous changes that pose huge challenges to established business models as well as to the way manufacturing processes are organised today. At the same time, many opportunities are arising from these developments, leading to new business models that focus, for example, on the individualisation of production, as well as on cost and efficiency gains as a result of shorter innovation cycles, shorter time-to-market or self-adaptation of production. Risk management is becoming increasingly important, especially in view of the constantly changing economic situation. Negative market developments and societal risks can lead to significant financial losses and, in the worst case, to the closure of a business. As a result, it is important that risks are not overlooked and risk management should be part of every company's activities. Despite the fact that the company faces risks, the company also has opportunities which, if properly exploited, can help it to compete or gain a better position in the market.

Risk management is getting more and more crucial at the moment, especially given how frequently the economic climate changes. Risks and unfavorable market trends that affect society can lead to significant financial losses, and in the worst situations, the closure of an enterprise. Because of this, it's critical that hazards are not undervalued, and risk management should be a part of any business. Despite the fact that the company is vulnerable to dangers on the one hand, they also have chances that, if they can take advantage of them, can help them compete or improve their position in the market.

The most crucial component of every equipment, gadget, and system in today's advanced society that has a mechanically active component is safety. This is a series of precautions to stop any part of the human operator from coming into contact or colliding with the machine during this movement. It is not at all easy to ensure the safety of machinery and equipment.

It is essential to address it at the outset of the project/application design and to incorporate it as effectively as possible right from the start of the mechanical building of the machines. It is necessary to treat or secure electronically any risks of danger that cannot be eliminated or suppressed by mechanical components (machine structure, covers, etc.).

2. Prerequisites and means for solving the problem

We describe risk management as a process in which the management makes appropriate suggestions to lessen the impact of negative effects and attempts to prevent the impact of current and future risks. On the other side, offers the chance to benefit from favorable consequences.

Business risk effects include:

- positive - they inspire the business entity and are viewed as a success if there is a profit,
- negative - they provide poorer results than anticipated and are connected to the development of a loss later on.

Business hazards can be divided into several different categories. Following is a breakdown of business risk by business area:

- production risks: insufficient resources or quality to ensure the production process,
- hazards associated with technical development of new product technologies,
- economic hazards, such as rising energy and raw material prices, international commerce, inflation, and conducting business in another state,
- business (market) risks include the availability of products on the market, competition, customer opinion, and the expansion of the firm itself,
- financial risks, such as the potential need for investment loans, changes in market interest rates, and accounting mistakes,
- political hazards, which are determined by the nation's political climate (economic policy of the government),
- media hazards - the impact of the media on an organization's market position,
- risks associated with information are tied to the advancement of communication and information technology.

The identification of potential dangers that could lower the degree of safety is accomplished through risk management. In order to set priorities and develop methods for mitigating them, the organization uses risk management, which is a method of analyzing, rating, and categorizing the risks that are encountered. Risk management, as we define it, is a continuous, systematic strategy to dealing with risk and uncertainty, in which we employ a variety of tools, methods, and strategies. It is a component of management that aims to guarantee the security and reliability of the system, procedure, undertaking, or business activity in general. [3]

Organizational risk management is used to assess and control organizational uncertainty in the form of adherence to corporate strategy and people, processes, and technology. The following principles must be adhered to in order for risk management to be applied inside the organization:

- complete backing from senior management,
- the application used by the entire company,
- educating all organization's human resources about risk management implementation,
- developing efficient methods for monitoring risk. [4]

Protecting and improving an organization's assets is the function of risk management. The following are the organizational goals that are supported by risk management in order to attain these objectives:

- provides better decision-making, planning, and prioritization based on a thorough and organized comprehension of business operations, project possibilities, and threats,
- aids in the company's usage and distribution of cash and resources more effectively,
- lessens turbulence in non-critical business areas,
- enhances and safeguards the business's resources and image,
- expands and supports the company's knowledge base as well as the expertise of its personnel,
- improves operational efficiency. [5]

Several standards and norms can be used in the firm to implement risk management. Each company chooses these standards and norms on an individual basis depending on their needs or the demands of its partners. ISO 31000: 2018 Risk management is the international standard that outlines general risk management practices. It is the source of STN ISO 31000: 2019 Risk management - instructions, the Slovak version of the standard. The standard, which is valuable to all individuals and groups without violating the law against discrimination - private, public, and social - is created for certain categories in the industry. [6]

The stages of the risk management process depicted in FIG. 1 are listed in this standard.

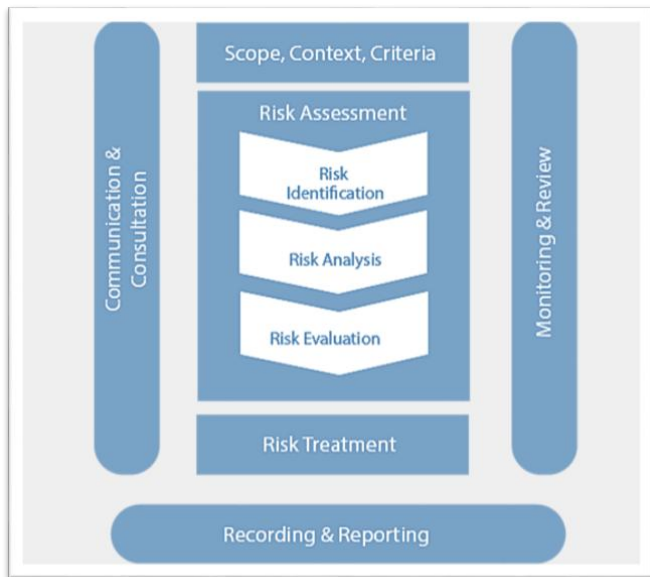


Fig. 1 Risk Management Process (Modified from: [6]).

The stages of the risk management process are a series of related actions and results that together form a cycle. This procedure, which is a crucial component of business management, needs to be adjusted to reflect modern business practices and corporate cultures. [3]

The risk database or the risk checklist is used to record identified risks. It is not advised to identify risks exclusively using this database and checklist.

The risk database is a compilation of organized data from previously completed projects. For usage in other projects, a formal risk information file serves as a suitable data retention mechanism.

The risk checklist is a list of potential danger zones. The issues are specific to a certain business. The list has been created expressly for a certain industry or type of business. Identification is not something we perform once, but rather something we do repeatedly or continually, depending on the situation. For this, we employ monitoring or early warning systems. On the basis of chosen indicators, they highlight the elevated risks associated with the

responsible party when the development of such risks exceeds the predetermined limitations or at other regular intervals.

In conclusion, I want to underline that the most crucial and time-consuming step in the risk management process is risk identification. It involves prior experience, systematic thinking, the capacity to foresee even those things that we do not yet expect and about which we know nothing, collaboration, and a focus on the future. [3]

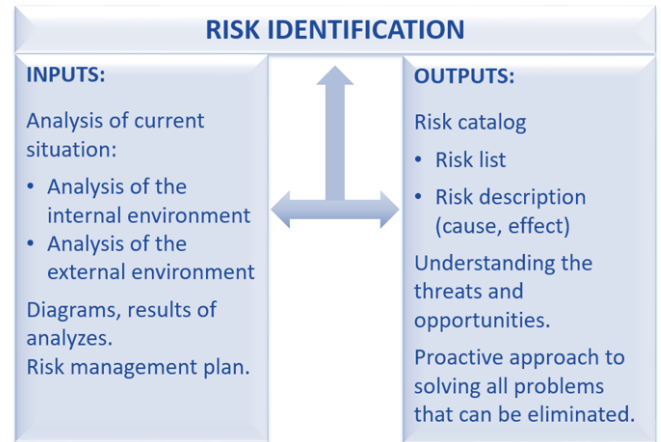


Fig. 2 Identification risk (Modified from: [3]).

If no precautions have been implemented on the machinery, it is assumed that an accident will eventually occur due to its inherent risks. To apply the principles of safe machinery design, one must first comprehend the use of the machinery, the history of accidents and medical records, the technologies available to reduce risk, and the legal context in which the machinery is to be used. [7]

Any machine design that may be justified today must no longer be true if technical developments make it possible to build the same machine with less risk. It is advised that a group of people do the risk assessment, while it is possible that several groups analyzing the same machine may not reach the same result. The process of assessing risk is unique to each person. The flowchart for the full process of risk assessment is shown in Figure 1. [8]

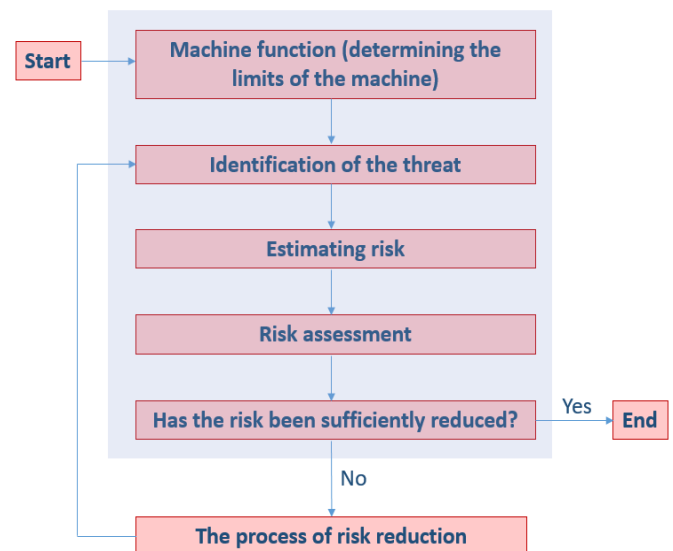


Fig. 3 Process of risk assessment of machinery.

3. Solution of the examined problem

The so-called "3-step method," where the machine manufacturer is required to adopt the following principles in the following order when selecting a measure, must be employed if the risk assessment has highlighted the need for further measures to minimize the risk.

Construction safety features

Developed design safety features lessen risks or minimize hazards by utilizing the machine's right design components and/or by interacting with exposed people and the machine. Hazards can only be removed at this stage, which eliminates the need for additional protective measures like safety guards or supplemental protective measures. [9]

Safety protection and additional protective measures

If it is not practicable to completely eliminate the hazard or sufficiently decrease its equivalent risk through built-in design precautions, suitable safety protection and extra protective measures may be used to lessen the risk, taking into account the predicted use and expected abuse. [9]

Usage information

The information for use must specify any residual hazards that exist even after taking additional preventive measures, safety safeguards, and built-in design safeguards. This information must at least contain the following, but not only that:

- recommended safe working practices for the use of the machinery and training requirements described accordingly; sufficient information, including warnings of residual risks for the various phases of the machinery's life,
- adequate information, including warnings of residual dangers for the various phases of the machinery's life,
- recommended safe working practices for the usage of the machinery and training requirements defined correspondingly,
- detailed description of any personal protective equipment that is suggested, including information on how to use it and what instruction is needed.

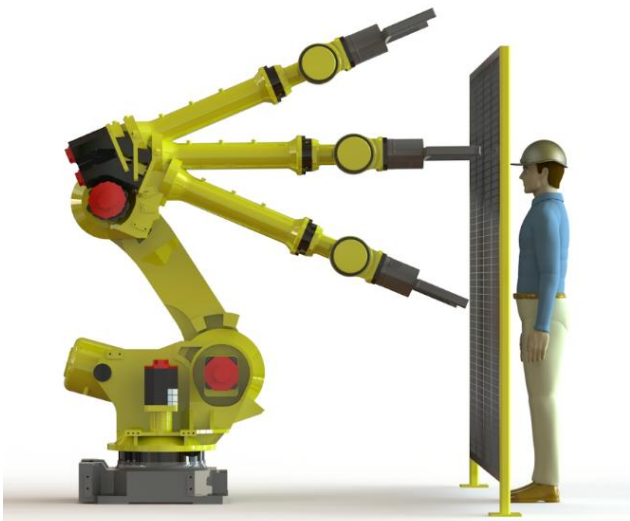


Fig. 4 Illustrative security protection [4].

The information provided for use is not intended to replace the proper use of any additional protection measures, safety guards, or built-in construction safety precautions. The likelihood that the operator will use risky technical interventions in the event of technical difficulties is reduced by the appropriate safeguards associated with each operating mode and intervention procedures. [7, 9]

4. Results and discussion

Constructed-in safety precautions

Including safety measures into the design itself is the first and most important step in the process of risk reduction. This is because the machine has inherent built-in safeguards that are always effective, but history has shown that even well-designed safeguards can break down or be evaded, and that usage instructions might not always be followed.

Built-in design safety measures are accomplished by removing hazards or reducing risks by choosing the proper design characteristics for the machine itself and/or interactions between exposed humans and the machine. If the built-in design safety measures are insufficient, chapter 6.3 of STN EN ISO 12100 describes the safety protection and supplemental protection techniques that can be used to achieve the risk reduction goals (three-step process). [11, 12]

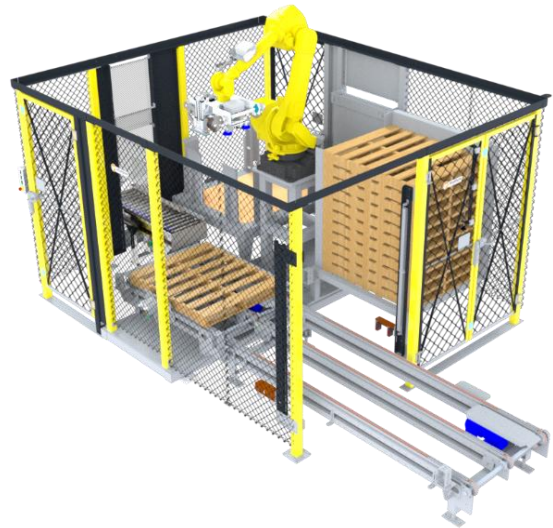


Fig. 5 Safe robotic cell [7]

Safety protection and additional protective measures

Guards and protective devices must be put in place for the protection of people if a built-in design safety precaution hasn't been able to entirely eliminate the risk or drastically reduce the risks. Additional safety measures could be taken by using other devices, like emergency stop devices.

By employing specific safety equipment, it is possible to avoid being exposed to various risks. A permanent guard, for instance, can be used to block access to a location with mechanical risks by reducing noise levels and capturing dangerous emissions. [11, 12]

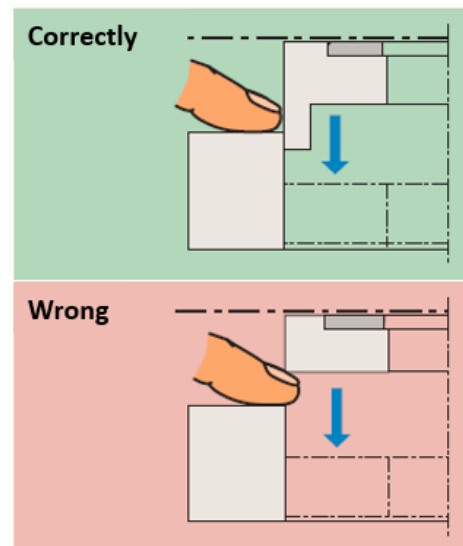


Fig. 6 Example of cutting point elimination [7]

Usage information

Machine design must include information design for use. The user is given the information using a variety of communication tools, including text, words, signs, signals, symbols, and diagrams, either separately or in combination. The recommended practices are intended for both professional and/or casual users.

The user must be given information on how the machine should be used, taking into account all of its operational modes.

The literature must contain all the instructions required to ensure that the machine is used safely and correctly. The user must be made aware of the lingering risk in this regard and informed of it. If training, personal protective equipment, or additional guards or protective devices may be necessary, it must be specified in the material as needed





Users must be made aware of the dangers of using the equipment in ways other than those recommended in the instructions for use, especially if misuse is anticipated. Use of the equipment that is expected to be reasonable given its intended use and description must be permitted.

The information for use must cover all of the following, either individually or collectively: transportation, assembly and installation, commissioning, use of the machine (setting up, learning/programming or changing the process, operating the machine, cleaning, fault-finding and maintenance), and, if necessary, decommissioning, dismantling, and disposal. [11, 12, 14]

Pictograms

Safety labels are a critical element of the usage instructions that machine manufacturers provide to users and are frequently the only instructions that many users can see. Because of this, the layout and positioning of safety labels are essential to their efficiency. The risk associated with improper or excessive use of safety labels is the same. Machine designers and users frequently opt for generic labels that are easily accessible from catalogs rather than having the chance to create labels that are unique to the machine and the risk. [15]

Table 1. Example of pictograms which can be used in risk assessment of machinery. [15]

Pictograms used	Meaning of the brand
	Caution, danger of being pulled in
	Caution, danger of crushing
	Attention flammable liquid
	Hand protection command

5. Conclusion

Every business should continuously adapt to changing client needs and the dynamic business environment if it hopes to establish or maintain its reputation in the market, make money, and improve its worth. The company is confronted with many risks as a result of the internal and external environments' rapid changes, and it is important to estimate these risks in a timely manner and take the necessary precautions to stop them from occurring or to decrease them to an acceptable level. Because of this, risk management for the firm is becoming especially critical.

Making sure that machinery and equipment is safe is not at all simple. It is crucial to take it into consideration from the very beginning of the project/application design and to incorporate it as effectively as possible from the very beginning of the mechanical construction of the machines. Risks of danger that must be managed or protected electronically because mechanical components cannot eliminate or suppress them (machine structure, coverings, etc.). Therefore, the residual risk needs to be explained in more detail in the documentation and on the equipment labels.

Safety against mechanical movements of machines has long been neglected, despite the fact that it can result in injuries just as severe as electric shocks, despite the fact that it is generally understood to be very important. Because the movement of modern automatic or semi-automatic machinery is now typically controlled by the program of the control unit, the structure of which is known only to the manufacturer's programmer, its behavior is not always predictable. Regardless of the machine control's unexpected behavior brought on by errors or unresolved error states. Using a purely "peasant approach" is not always possible: "When I am careful."

6. Acknowledgement

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