

# RISK ASSESSMENT FOR THE PRODUCTION PROCESS

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**Abstract:** Risk management constitutes currently one of the most important elements of the management of an enterprise, which is crucial to its security and continuous improvement. This is a several-stage process, and its implementation should be systematic and principled in character. The article sets out the risk assessment for activities performed in conjunction with individual operations of a manufacturing process, and specifically, the book production process. The risk assessment was preceded by the identification of hazards to technological, transport and control operations, followed by their analysis using an indicator method. Operations have been identified, which are characterized by the highest risk, and preventive and prophylactic actions using various control measures (technical, organizational, legal, individual and collective) have been proposed. Risk assessment for a task is a primary outline for the use and implementation of risk management issues that go beyond the commercial risk assessment in an enterprise.

**Keywords:** RISK MANAGEMENT, RISK, ANALYSIS, ASSESSMENT, HAZARDS, PRODUCTION PROCESS

## 1. Introduction

Undoubtedly, risk management is an important and increasingly common element of an enterprise's functioning, as it relates to a broad spectrum of its activity. It guarantees the improvement of safety, the ability to foresee the consequences of hazards, and the proper decision-making and strategic planning. Moreover, risk management helps with recognizing the whole area of the organization's activity, monitoring hazards and preparing for the occurrence of crisis situations in the company. Risk management determines the weaknesses and strengths of an enterprise, which enables its continuous improvement.

The risk management process comprises several stages: the definition of the activity context, the identification, analysis and assessment of the risk and the response to the risk, along with continuous monitoring and communication [8,11].

The determination of the context is to indicate the main targets and objectives of an entity, for which the hazards are being considered, and to establish all circumstances of the functioning of the process. The identification involves the establishment of the actual or potential hazards, their causes and effects, and the subjects and objects affected by the hazard. Risk analysis relates to the selection of the appropriate risk measurement method that uses the parameters of the risk (in the study, the value of probability, effects and exposure has been determined). In turn, the job of risk assessment is to establish the actual risk level and then to select the appropriate variants of actions [9, 11].

In a modern enterprise we deal with the examination of the level of different risk types: production, financial, commercial, legal, technological, innovation-related, etc. An interesting concept, on the other hand, is also the practice related to the assimilation of risk assessment in the production process for specific process operations and individual tasks performed in conjunction with them. This is a new look at the hazard of the entire production process (being useful during the implementation of new technologies, transformation of the production line and development of the job-stand instruction), as well as in the context of the Health Safety of employee work.

The production process is an ordered sequence of activities, as the result of which the consumer obtains products and services. This is part of the production system and comprises: technological operations denoted conventionally with the symbol of a circle; storage operations (triangle); control operations (square); and transport operations (arrow) [1].

The book production process constitutes part of the production system. Therefore, in order that it could be carried out, input elements, such as materials, utilities, fixed assets, information and personnel, are needed. The output product is a book with

appropriate utility, economic, natural, ergonomic and technical features, as well as waste material and impurities. In the printing and publishing process, all factors that constitute potential hazards to it (i.e. production materials, such as adhesives, paints and solvents that could be hazardous, or e.g. noise emitted by machinery, which is a by-product of the process) should also be taken into account.

The paper is focused on the book production process, though, obviously, printing companies deal with the manufacture of various products and their product-range variety is constantly expanding. Therefore, the printing and publishing industry in Poland is developing vigorously and dynamically. Indeed, an increase in demand for its products and an increased employment in this industry have been observed in recent years. In terms of its revenues, the Polish printing and publishing sector remains the largest sector in Central and Eastern Europe and is placed eighth in the European Union. Currently, almost 8800 printing businesses are active in Poland [7, 10].

## 2. Prerequisites and means needed to solve the problem

The book printing and publishing process is composed of three phases: printing preparation (pre-press), printing and bookbinding and shipment activities. From among them, six operations were selected, for which risk assessments were made.

In order to make risk assessment for the production process, it was necessary to perform the following activities for its individual tasks and operations:

- establish the individual operations of the production process and to define their types (using conventional symbolism);
- identify potential hazards and to determine their effects (technical, commercial, outer factors-related and information safety-related hazards);
- make a risk analysis using the indicator (*risk score*) method using three risk parameters: probability, exposure and effects;
- perform the proper risk analysis of the identified production process hazards;
- select the means of control (preventive and control actions, collective, individual, technical, organizational and legal measures) for hazards characterized by the highest risk level; and
- develop conclusions and recommendations.

The risk assessment for individual production process operations was made based on the printing and publishing process of a selected printing company active on the Polish market.

### 3. Risk assessment for the book production process

Table 1 shows selected operations of the book printing and publishing process, the identification of risks and their potential effects.

**Table 1:** Identification of risks for individual phases of the book production process

Phase/ Operation name/	Risks	Effects
<p><i>Pre-press</i></p> <p>1. editing 2. matrix-moulding 3. making printing formes</p> 	<p>a. accidental disclosure and/or loss of information b. computer viruses c. hardware failure d. harmful radiation from hardware e. mains failure f. UV radiation g. contact with chemicals h. mechanical, machine-in-motion hazards i. stress and working under time pressure j. inadequate lighting k. static and dynamic employee loads</p>	<p>disclosure of information and data to unauthorized people, no material available for editing, extended working time, repair and service costs, excessive exposure, harmful effects of chemicals on human body, poisoning, feeling unwell, fractures, bruises, crushing, pricks, cuts, inefficient employee work, working discomfort, body function disorders, power outages</p>
<p><i>Printing:</i></p> <p>1. pre-press proofing 2. run printing 3. quality control during printing and making corrections</p> 	<p>a. harmful radiation b. contact with chemicals c. noise d. vibrations e. electrocution f. mains failure g. mechanical and machine-in-motion hazards h. inadequate lighting i. surface configuration hazards (difference in levels; slippery, uneven surfaces) j. no procedures and machinery instruction manuals translated into the native language k. static and dynamic employee loads l. changing microclimate l. confined space m. water-pipe network failure n. poor working ergonomics o. working alone p. machine/equipment failure r. stress and working under time pressure s. dustiness, chemical vapours and gases t. room or building structure collapse u. faulty production/run, excessive spoilage</p>	<p>working discomfort, body function disorders, fractures, bruises, crushing, pricks, cuts, electrocutions, burning, dislocations, spraining, allergies, overexposure, vision impairment, harmful chemical effects on human body, filling unwell, accidents at work, infrastructure damage, material losses, power outages, prolonged threat response time, added production costs, work disruption and destabilization, communication problems</p>
<p><i>Bindery and shipment:</i></p> <p>1. transport to bindery 2. cutting 3. folding 4. transport to stitching 5. thread sewing</p>	<p>a. fire b. explosion c. noise d. vibrations e. mechanical and machine-in-motion hazards d. hazards involved with non-routine repairs of machines and their parts e. static and dynamic</p>	<p>working discomfort, body function disorders, fractures, bruises, crushing, pricks, cuts, electrocutions, burning, dislocations, spraining, allergies, overexposure, vision impairment, harmful</p>

<p>6. pressing 7. glueing 9. book bulk trimming 10. setting individual cover elements 11. book back forming 12. book cover stamping 13. suspending book bulk into the cover 14. book bulk and cover inspection 15. pressing 16. jacket folding and putting on 17. transporting to the packing stand 18. packing into packets 20. transporting to the finished product storage</p> 	<p>employees loads f. confined space h. collapse of a building or a structure part h. traffic accident i. incorrectly designed fire protection j. no fire-fighting equipment available at the proper distance from the job stand and at the adequate quantity k. no active safety system l. falling objects l. radiation m. stress and working under time pressure n. dustiness, chemical vapours, liquids and gases o. electrocution p. microclimate r. water-pipe network failure s. mains failure t. inadequate lighting u. traffic accident w. surface configuration hazards (difference in levels; slippery, uneven surfaces) y. poor working ergonomics x. faulty production/run, excessive spoilage z. working alone</p>	<p>chemical effects on human body, filling unwell, accidents at work, infrastructure damage, material losses, power outages, traffic disruptions, prolonged threat response time, added production costs, work disruption and destabilization, extended working time</p>
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*Source:* The authors' compilation based on the data obtained from the enterprise

Table 2 shows the risk analysis of the identified book production process risks using the risk score method that makes use of three risk parameters: probability, exposure and effects. The description of the method provided in Tables 3 through 5, respectively, was used for this purpose. Table 3 provides the description of the exposure along with values assigned to it. The description of probability together with its values is given in Table 4. Whereas Table 5 shows the description and values of effects for the selected method.

**Table 2:** Risk analysis of the identified printing and publishing process risks

No.	Risk	P	E	S	W
1.	fire	0.2	3	15	9
2.	explosion	0.2	3	15	9
3.	noise	10	6	1	60
4.	vibrations	10	6	1	60
5.	mechanical and machine-in-motion hazards	6	6	7	252
6.	hazards involved with non-routine repairs of machines and their parts	0.5	2	3	3
7.	static and dynamic employees loads	1	6	1	6
8.	confined space	3	6	1	18
9.	collapse of a building or a structure part	0.1	0.5	40	2
10.	traffic accident	1	0.5	15	7.5
11.	incorrectly designed fire protection	0.1	0.5	7	0.4
12.	no fire-fighting equipment available at the proper distance from the job stand and at the adequate quantity	0.1	0.5	7	0.4
13.	no active safety system	0.5	1	7	3.5
14.	falling objects	6	3	3	36
15.	radiation	10	6	1	60
16.	stress and working under time pressure	1	3	1	3
17.	dustiness, chemical vapours, liquids and gases	6	6	3	108

18.	electrocution	6	6	3	108
19.	microclimate	1	3	1	3
20.	water-pipe network failure	0.2	0.5	3	0.3
21.	mains failure	0.5	0.5	3	0.75
22.	inadequate lighting	3	6	1	18
23.	surface configuration hazards (difference in levels; slippery, uneven surfaces)	6	6	3	108
24.	accidental disclosure and/or loss of information	1	0.5	3	1.5
25.	computer viruses	6	6	3	108
26.	hardware failure	6	2	3	36

Source: The author's study

Table 3: Estimation of the parameters of exposure to risks in the risk score method

E- exposure to the risk	
Value E	Exposure description
10	Permanent exposure
6	Frequent (everyday)
3	Once a week
2	Once a month
1	Several times a year
0.5	Rare (once a year)

Source: [2, 6]

Table 4: Estimation of the probability parameters in the risk score method

P - risk occurrence probability			
Value P	Description	Chance in %	Probability
10	Very probable	50	0.5
6	Quite probable	10	0.1
3	Practically possible	1	0.01
1	Little probable, though possible	0.1	0.001
0.5	Only sporadically possible	0.01	0.0001
0.2	Thinkable	0.001	0.00001
0.1	Theoretically possible	0.0001	0.000001

Source: [2, 6]

Table 5: Estimation of the effect parameters in the risk score method

S - possible risk effects			
Value S	Estimated losses	Human losses	Material losses
100	Severe disaster	Numerous fatalities	Over 30M ZI
40	Disaster	Several fatalities	10 – 30M ZI
15	Very large	One fatality	300K – 1M ZI
7	Large	Serious injuries	30 – 300K ZI
3	Medium	Absence from work	3 – 30K ZI
1	Small	Offering first aid	Below 3K ZI

Source: [2, 6]

The main stage of the studies presented in this paper included the risk assessment of the identified risks to the printing and publishing process along with control mechanisms (corrective and preventive actions) assigned to them. This assessment is illustrated by Table 6 based on the risk categories presented in the risk score method (Table 7).

Table 6: Risk assessment of the identified production process risks along with control mechanisms

Risk number	Risk assessment	Control mechanisms
1.	acceptable	Control recommended
2.	acceptable	Control recommended
3.	Low	Control needed
4.	low	Control needed
5.	high	Immediate risk mitigation is required. The use of the LOTO system, installation of proper shields, provision of job stand training, adherence to safety instructions, translation of instruction manual into native language, proper maintenance of machines and frequent inspection of machinery and equipment are needed.
6.	acceptable	Control recommended
7.	acceptable	Control recommended
8.	acceptable	Control recommended
9.	acceptable	Control recommended
10.	acceptable	Control recommended
11.	acceptable	Control recommended
12.	acceptable	Control recommended
13.	acceptable	Control recommended
14.	low	Control needed
15.	low	Control needed
16.	acceptable	Control recommended
17.	significant	Risk mitigation is required. Adequate ventilation and air conditioning, personal protective equipment (safety glasses, gloves, etc.), measurements of noxious agents at work stations and extraction equipment are needed.
18.	significant	Risk mitigation is required. The inspection of technical equipment condition, job stand training, following the strictly defined procedures and taking measurements using a mains parameter measuring instrument are needed.
19.	acceptable	Control recommended
20.	acceptable	Control recommended
21.	acceptable	Control recommended
22.	acceptable	Control recommended
23.	significant	Risk mitigation is required. Install guard rails, provide job stand training, maintain tidiness, wear suitable protective shoes, employ anti-slip protection, logistic solutions, industrial lining
24.	acceptable	Control recommended
25.	significant	Risk mitigation is required. The protection of services, software, communications, data storage media safeguarding, personal safety and data protection (locks, passwords, information and data encoding) are needed.
26.	low	Control needed

Source: the author's study

**Table 7:** Risk assessment – risk categories in the risk score method

Risk - R		
Value	Category	Preventive action
At most 20	Acceptable	Control recommended
At most 70	Small	Control needed
At most 200	Significant	Risk mitigation required
At most 400	Large	Immediate risk mitigation required
Over 400	Very large	Work withholding

Source: [2, 6]

### 3. Conclusions

To sum up the discussion of the risk assessment of the printing and publishing process under consideration, the following conclusions can be drawn:

- the pre-press phase of the book printing of publishing process comprises chiefly technological operations, while the printing phase relies both on technological and control operations. In the bindery and shipping phase, on the other hand, we deal with both technological, control and transport operations. So, in the technological process under investigation, operations that are characterized by the highest risk concern mainly the printing and bindery phases;
- a risk type that most often occurs in the printing and publishing process, in all its phases, includes risks associated with mechanical and chemical hazards, as well as radiation, noise and vibrations;
- the highest probability of occurrence is exhibited by hazards, such as noise and vibrations. The greatest risk exposure applies to: noise and vibrations generated by machines, mechanical and machine-in-motion hazards, dynamic and static loads, radiation, confined space, motion, dustiness, chemical liquids and gases, electrocution, inadequate lighting, surface configuration hazards (difference in levels; slippery, uneven surfaces) and information safety hazards, chiefly computer viruses. Whereas, the risks characterized by the largest material and human losses are: the collapse of a building or a structure part, fire, explosion and a traffic accident;
- the highest risk level of all the identified risks applies to hazards, such as (high risk) mechanical and machine-in-motion hazards. A significant level, on the other hand, was assessed for the following risks: dustiness, chemical vapours, liquids and gases, electrocution, computer viruses and surface configuration hazards (difference in levels; slippery, uneven surfaces);
- using control mechanisms is necessary at both high and significant risk levels, while at the remaining levels, the control is either needed or recommended. Therefore, from among the preventive and control actions, the following individual, collective, organizational, legal and technical measures are recommended to be used: the LOTO system, proper shields for machinery and equipment, job stand training, adherence to safety instructions, translation of instruction manuals into the native language, the proper maintenance of machines, frequent inspection of machinery and equipment, guard rails, maintaining jobs station tidiness, using relevant logistic solutions, anti-slip protection, information protection, personal safety, adequate room ventilation and air conditioning, or noxious factor measurements;
- the risk assessment of a production process should be made cyclically, especially with the aim of verifying the effectiveness of control mechanisms used (so-called residual risk), each time after process changes, job station rotations, or the implementation of innovative solutions.

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