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ORIGINAL RESEARCH PAPER

RISK MANAGEMENT IN INDUSTRIAL COMPANIES, CASE STUDY: COLLECTIVE WORK ACCIDENT AT A BREWERY

Luminita Bibire[1], Florin Ion Lazar[2], Alexandra-Dana Chitimus[1*], Adrian Stelian Ghenadi[1*]

[1] "Vasile Alecsandri" University of Bacau, Faculty of Engineering, 157 Calea Marasesti, 600115, Bacau, Romania
[2] Territorial Labor Inspectorate, Ionita Sandu Sturza St., 600269, Bacau, Romania

*Corresponding author: dana.chitimus@ub.ro, adrian_ghenadi@ub.ro

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Abstract: The purpose of the paper is to emphasize the importance of the efficient application of risk management. As factor in preventing events on the field of health and safety at work in food industry. The study presents an analysis performed on the indicators regarding work accidents registered in BREWERY factory from Bacau County, within the North-East Development Region and at national level respectively, during the period 2012 - 2017. The research carried out during the preparation of the accident file, exemplified in the study case, underline that the faulty implementation of risk management has the effect the producing of unwanted events, on the field of occupational health and safety.

Keywords: *food industry accidents, occupational health, risk management*

INTRODUCTION

The concept of occupational health and safety is known as the process of knowledge and the removal of problems, which may arise and disrupt the work process, capable of causing occupational illnesses and / or accidents at work [1 – 12].
In order to avoid these unwanted events, it is very important for any industrial company to have an efficient risk management system. The implemented risk management system must be complied with European and national provisions regarding occupational health and safety. The analysis of indicators regarding occupational health and safety at national and regional level, by types of industries and accidents is extremely useful for improving the risk management system [6, 11, 13 – 30].
The paper presents a study on accidents at work, at regional level (North-East Development Region) in the period 2012-2017. The case study presented in the paper, for a collective work accident, from the food industry, highlights the serious consequences of incorrect implementation of risk management.
Romania's constitution distinctly emphasizes the place and role of occupational health and safety legislation in the national legislative system: a component of the regulatory system that aims to ensure the protection of citizens, respectively for a specific segment of the active population, against the risks of accident and / or occupational illness generated in any work process [31].
By Constitution of Romania, which stipulates the right to social protection for all workers, regardless of whether they are employees of economic agents with state or private capital, the unitary regulation of the state and the private sector is realized starting with the framework law, for the entire activity of health and safety at work [32].

RESEARCH METHODS

Analysis of the number of work-related accidents in Bacau County, and its positioning, within the North-East Development Region, and at national level, between 2012 and 2017

From Table 1 it can be seen that, the number of work accidents in Bacau County was 93 persons in 2017, increasing with 47.6 % respectively 4.5 % compared to 2016 respectively 2012.

Table 1. *Number of work accidents, by types of accidents, and by counties of the North-East Development Region*

Region/ ***type of accidents***	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
North-East Development Region (total accident)	**375**	**378**	**363**	**315**	**295**	**379**
Temporary incapacity for work						
North-East Development Region	321	333	322	279	257	338
Bacău	78	68	67	55	58	82
Botosani	38	22	31	25	30	45
Iasi	91	94	98	77	58	71
Neamt	53	69	43	55	40	64
Suceava	40	62	57	45	40	51
Vaslui	21	18	26	22	31	25

Fatal accident						
North-East Development Region	54	45	41	36	38	41
Bacău	11	13	10	7	5	11
Botosani	2	3	4	4	6	5
Iasi	15	6	7	7	6	6
Neamt	12	7	12	6	12	11
Suceava	10	14	5	9	5	5
Vaslui	4	2	3	3	4	3

Figure 1 presents that, Bacau County, is on 30th place at the national level, and the last place in the North-East Development Region in 2017.

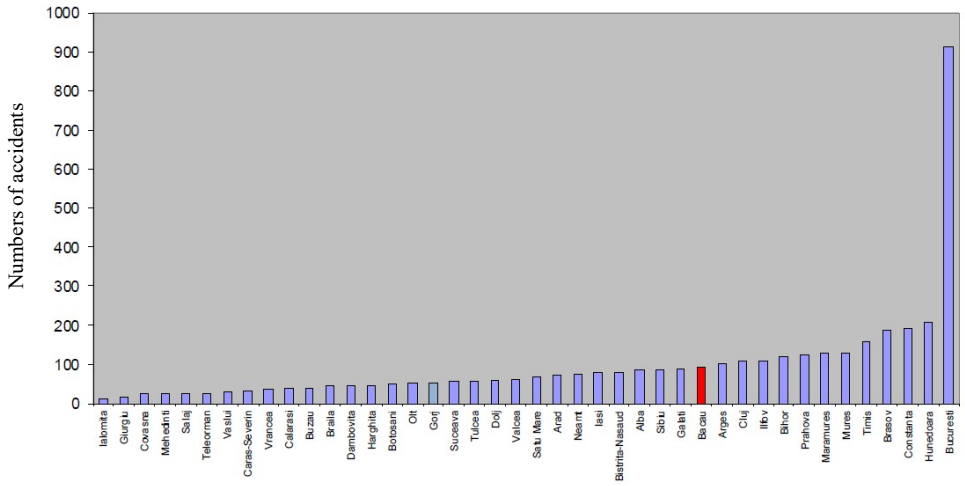

Figure 1. *Distribution of the number of accidented persons during 2017, by counties*

As can be seen from Figure 2, with this number of work accidents, Bacau County is positioned on the last places, during the analyzed period, within the North-East Region (ranking in the ascending order of this indicator), the lowest weight being in the year 2017 (19.7 %).

Regarding the dynamics of the number of work accidents, from Bacau County, as calculated and presented in Table 2, it shows a decreasing trend in the period 2015-2017 (the year 2017 compared to the year 2016, registering the smallest decrease by 12.2 %), while, in the last 2 years, an evolution is observed compared to the previous year.

The number of casualties with temporary incapacity for work, in 2017, in Bacau county level, was 82 persons, representing 88.2 % of the total number of casualties. With this number of casualties, Bacau County is ranked on 29th at national level.

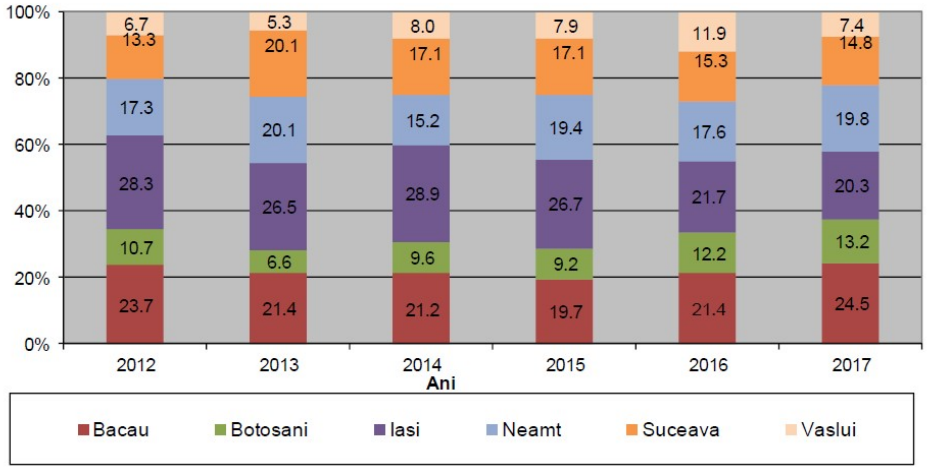

Figure 2. *Evolution of the structure of the number of work accidents, by counties of the North-East Development Region (%)*

As can be seen from the Figure 3, according to the distribution by counties, the municipality of Bacau is positioned on the last place, from point of view of this indicator.

Table 2. *Dynamics of work accidents, by types of accidents and by counties of the North-East Development Region, compared to the previous year (previous year = 100)*

Region/ *type of accidents*	**2013**	**2014**	**2015**	**2016**	**2017**
North-East Development Region	**100.8**	**96.0**	**86.8**	**93.7**	**128.5**
Temporary incapacity for work	103.7	96.7	86.6	92.1	131.5
Fatal accident	83.3	91.1	87.8	105.6	107.9
Bacau	91.0	95.1	80.5	101.6	147.6
Temporary incapacity for work	87.2	98.5	82.1	105.5	141.4
Fatal accident	118.2	76.9	70.0	71.4	220.0
Botosani	62.5	140.0	82.9	124.1	138.9
Temporary incapacity for work	57.9	140.9	80.6	120.0	150.0
Fatal accident	150.0	133.3	100.0	150.0	83.3
Iasi	94.3	105.0	80.0	76.2	120.3
Temporary incapacity for work	103.3	104.3	78.6	75.3	122.4
Fatal accident	40.0	116.7	100.0	85.7	100.0
Neamt	116.9	72.4	110.9	85.2	144.2
Temporary incapacity for work	130.2	62.3	127.9	72.7	160.0
Fatal accident	58.3	171.4	50.0	200.0	91.7
Suceava	152.0	81.6	87.1	83.3	124.4
Temporary incapacity for work	155.0	91.9	78.9	88.9	127.5
Fatal accident	140.0	35.7	180.0	55.6	100.0
Vaslui	80.0	145.0	86.2	140.0	80.0
Temporary incapacity for work	85.7	144.4	84.6	140.9	80.6
Fatal accident	50.0	150.0	100.0	133.3	75.0

Regarding the positioning of Bacau County, in the North-East Region, in 2017, Bacau County is also ranked at last place, with the highest number of accidented persons.

In 2017 compared to 2016, the number of accidented persons with temporary incapacity for work increased considerably compared to the previous year, with 41.4 %, being, the highest increase in Bacau county, during the analyzed period.

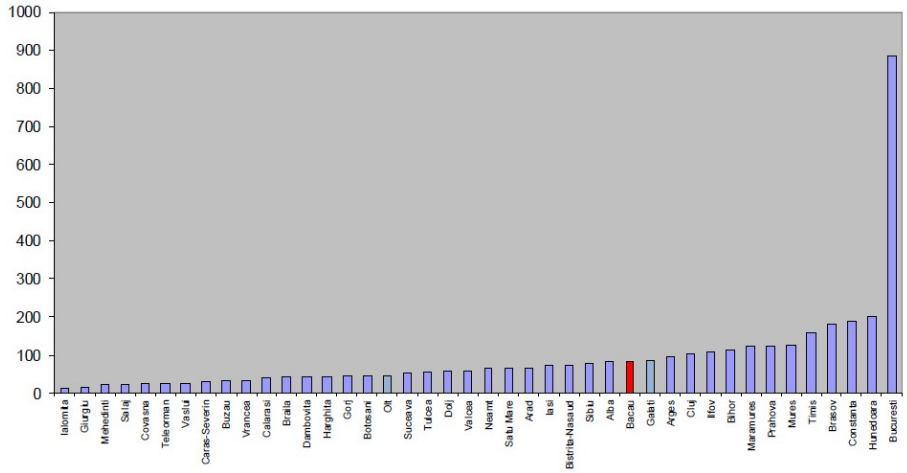

Figure 3. *Distribution accidented persons number, with temporary incapacity for work, during 2017, by counties*

The number of deadly accidented persons, in 2017 in the county of Bacau, was 11 persons, representing 11.8 % of the total number of victims from the county level, and 26.8 % of the number of deadly accidented persons from the region.
With this effect, Bacau county is ranked on 37th at national level, unfortunately, disputing penultimate place in the country, with Neamt county, as can be seen in the Figure 4.

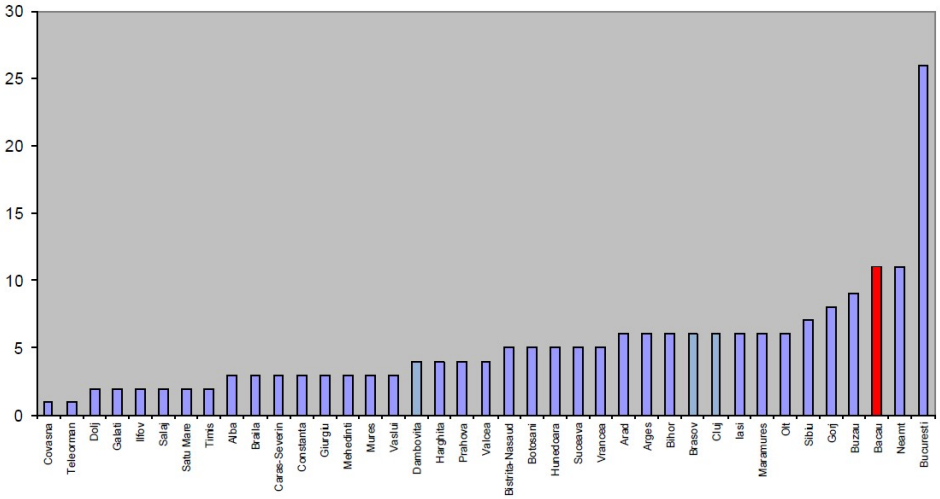

Figure 4. *Distribution of fatal accidents persons number, during 2017, by counties*

From Figure 5, it can be seen that the lowest share of deadly accidents persons in 2017, within the North-East Region, is registered in Bacau County (88.2 %).

The rate of work accidents represents the frequency of accidents, or the number of accidented persons corresponding to 1000 employees, and in 2017 was 0.83 in Bacau county, above the average of the North East Region.
As can be seen from Table 3, except for 2014 and 2015, during the whole analyzed period, the rate of work accidents was higher than the regional average. Compared to the average of the country, except for 2017, when the values registered in Bacau county was equal, in all other years the values of the rates were lower than the level of Romania.

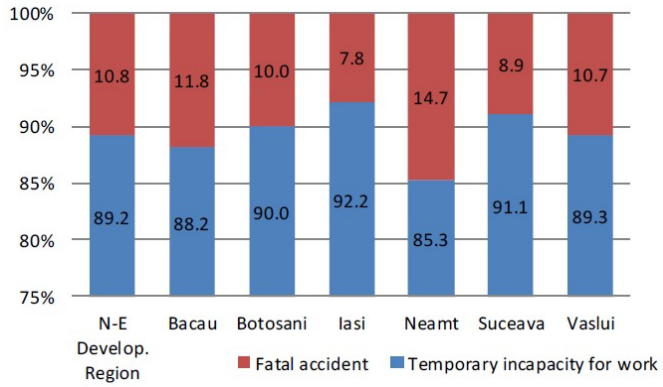

Figure 5. *Structure of the number of work accidents, by accident categories and by counties, of North-East Development Region, during 2017 (%)*

Table 3. *Rate of work accidents, in the North-East Development Region, by counties (accidents per 1000 employees)*

Region	2012	2013	2014	2015	2016	2017
North-East Development Region	**0.69**	**0.66**	**0.71**	**0.59**	**0.54**	**0.71**
Bacau	0.80	0.71	0.70	0.59	0.59	0.83
Botosani	0.60	0.38	0.71	0.54	0.67	1.03
Iasi	0.70	0.62	0.74	0.56	0.42	0.51
Neamt	0.98	1.13	0.78	0.78	0.65	0.98
Suceava	0.56	0.76	0.66	0.56	0.46	0.60
Vaslui	0.41	0.33	0.58	0.47	0.65	0.59

Figure 6 is suggestive to best represent the fact that the values recorded in Neamt County on this indicator are significantly higher than the rates recorded in the other counties.

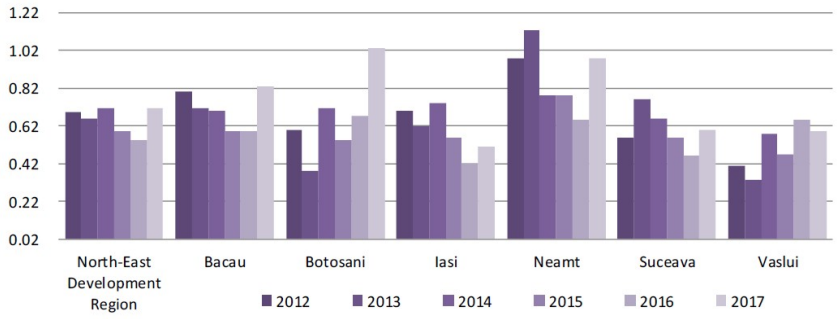

Figure 6. *Rate of work accidents, from the North-East Development Region, by counties*

CASE STUDY: COLLECTIVE WORK ACCIDENT IN A BEER FACTORY

Information on the work process in which the accident occurred

The beer is bottled, and it is transported in barrels, when the distance from the place of sale is large, as well as when the demand for beer is high, especially during the hot season, and in areas with high beer consumption.

The oak barrels had a great share in the marketing of beer. The crisis of the hardwood material and the laborious maintenance work led to the emergence of metal barrels from aluminum alloys and stainless steels.

Lately, the use of cylindrical barrels, made of stainless-steel sheet, called KEG, has spread. They can be 30 L and 50 L, the wall thickness being 1 ÷ 2 mm (Figure 7) [33].

Figure 7. *Cylindrical barrels keg [33]*

This type of barrel is equipped with a complex system called Sankey, permanently installed, which allows filling, emptying, cleaning and sterilization. The advantages of using these barrels are [33]:

- all transport and storage operations can be automated;
- cleaning, sterilizing and filling can be automated;
- there are closed vessels with automatic leak detection;
- allow easy handling for distribution, including the possibility of partial emptying;
- few manipulations are required during bottling, transport and draining of beer for consumption;
- the barrels are returnable when they still contain excess carbon dioxide pressure;
- contamination from the external environment is avoided.

The Sankey type system is a component of the barrel, and is fixed by screwing, and during transport it is protected by a plastic cover.

In order to avoid carbon dioxide losses, when filling the barrels and the bottles, an isobarometric installation is used. It allows, before the introduction of the beer, the creation in the barrel, or in the bottle, of an overpressure equal to that of the beer tank of the machine.

The installation consists of a beer tank, in which the beer brought by the filtration is maintained at an overpressure of 0.06 ÷ 0.14 MPa. With the help of compressed air, the filling device pipe is lowered to the bottom of the beer barrel, while the barrel valve is sealed. The air pipe is then opened, thus becoming in the barrel, the same overpressure

as that of the beer tank. By manipulating the valve of the filling device, the inlet of the compressed air in the barrel is closed, and the beer inlet is opened.
The beer gradually removes air from the barrel, which returns to the beer tank. When the barrel has been filled with beer, the beer passage is noticed through the control lantern, and the barrel is automatically stopped. The foam which is formed in the barrel during filling is collected in the foam catcher, and the beer resulted from this foam, which is contaminated, is discarded periodically, disinfection of the foam catcher is performed.
After filling, cap is placed. Metal barrels close with a threaded cap.

Detailed description of the place where the accident occurred and of the equipment under investigation, identified as causing of the accident
The event took place in a beer factory, in the beer bottling in KEG barrels section, the opening and checking area of KEG barrels [34].
The hall where the finished-filtered beer bottling in KEG-type barrels is made, has a length of 80 m, a width of 30 m and a height of 10 m, being provided with the loading / unloading ramp. The handling of pallets with barrels is done with the forklift.
The barrel type KEG, Czech manufacture, involved in the causing of the event has the series 210558 and it is equipped with the fitting series 8511 [34].
KEG barrels, having the following dimensions: height 600 mm, outer diameter 400 mm, mass 12 Kg, provided with safety yielding at a pressure of 0.35 (+/- 0.05) MPa, are made of stainless steel. They have a capacity of 50 liters, the maximum admitted pressure 0.35 MPa, being loaded with beer under the air "pillow", at a pressure of 0.22 / 0.25 MPa (Figures 9 - 12) [34].
The KEG barrel fitting is made of stainless steel, and consists of a rod, fitted with a metal head, with a sealing gasket and a valve for supply-emptying [34].

Work procedure
The activity in the beer bottling section in KEG-type barrels is carried out continuously, according to the requests of the sales office.
The working procedure in the process of bottling the KEG barrels consists of the following activities [34]:
- the conditioning of KEG type barrels:
    - the filling-emptying fitting is removed;
    - it is verified the interior surface, using a portable lamp, powered at 24 V;
    - in the manual mode, the barrels are passed on the gravitational roller conveyor;
    - it is verified the movement of KEG barrels with the gravitational roller conveyor, to the external washing machine;
    - the KEG barrels are passed to the COMAC machine type LINE 4 + 2T (Figure 8) which is composed of three modules, each module being provided with four heads corresponding to the four operations, for the operations of pre-washing, washing and rinsing, sterilization indoor;

Figure 8. *COMAC Machine [34]*

Figure 9. *Section of KEG barrel [34]*

- the actual filling of the KEG barrels; the filling is done with COMAC machine.

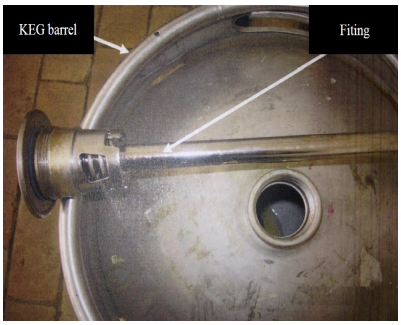

Figure 10. *Photo from research file (KEG barrel, fitting) [34]*

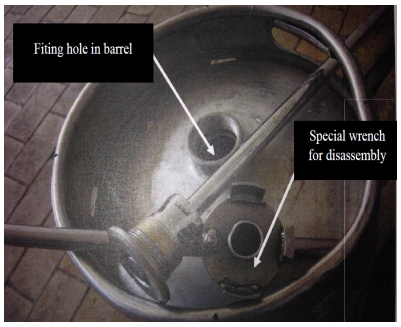

Figure 11. *Photo from research file (fitting hole in barrel and special wrench for disassembly) [34]*

For opening of KEG barrels in order to check them, a special key is used, depressurizing the barrel and unscrewing the fitting:
- KEG barrel is depressurized, in protected space specially arranged for this type of operation;
- ripping the fittings.

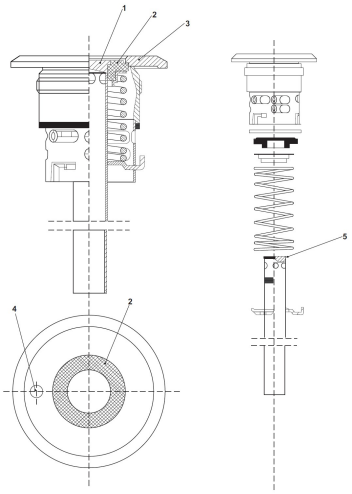

Figure 11. *Photo from research file (technical sketch) [34]*

Detailed description of the circumstances in which the accident occurred

On 10.10.2018, at around 08:30, the worker L.I. appeared at the work in the Central Mechanical Workshop, according to the schedule, at exchange of work I. After L.I. equipped himself with the individual protective equipment (cap, overall and non-slip boots), went together with other two teammates, P.I. and B.G. to the bottling beer section in KEG barrels according to the work schedule of workers from the Central Mechanical Workshop [34].

Between 09:15 and 10:30, the head of section KEG bottling of beer, engineer R.N., prepared the installation for washing KEG barrels and bottling beer in them, and the workers L.I., P.I. and B.G. checked and prepared KEG barrels for their washing and bottling with beer [34].

Starting at 10:30 a.m., the worker P.I. was assigned to the filling line, for carrying out the labeling and mounting operations for protection of the barrels, the worker B.G. was assigned to the filling line, for carrying out the operations of transporting KEG barrels, from the band with the help of the crane, and their palletizing, while L.I. continued the activity of external and internal verification of these barrels [34].

At about 11:45 a.m., the head of bottling station for KEG barrels, engineer R.N., asked the worker L.I. if he checked with the control lamp one of the KEG barrels. Receiving a negative response, she asked him to check that barrel in her presence [34].

At that moment, L.I. took the special key for checking the barrels, leaned over the barrel, fixed the special key on the barrel fitting and proceeded directly to unscrew the fitting, without pressing it, in order to remove the remaining pressure from the barrel [34].

Detailed description of how the event took place

Worker L. I. started the unthreading of the fitting, a noise was heard as a result of the sudden release of the remaining pressure, and the fitting was threwed with power from the barrel, hitting him in the front area of the head [34].

Following this blow L.I. fell in the vicinity of the barrel in a conscious state. After this event with the help of his colleagues, he was lifted and taken to the exit, being later transported to the County Emergency Hospital [34].

At the time of the event, respectively when he heard the noise caused by the sudden release of the remaining pressure from the barrel, the worker B.G., lost control of the lifting system with which he took over the KEG barrel from the conveyor belt. The KEG barrel, out of control, At the time of the event, respectively when hearing the noise caused by the sudden release of the remaining pressure from the barrel, the worker B.G., lost control of the lifting system with which he took over the KEG type barrel on the conveyor belt. The KEG barrel, out of control fell over the right foot of the worker who was handling the barrel, crushing his leg [34].

Worker B.G., fell near the KEG barrels, which he was preparing for palletization. He was picked up and taken out of the section with the help of his colleagues and later transported to the County Emergency Hospital.

At the this time of the event occurred, respectively at the noise caused by the sudden release of the remaining pressure from the barrel, the head of section, engineer R.N. suffered a shock, crashing near the stack of pallets with barrels, in a state of consciousness. She was led by the section colleagues to the exit, accepting care, but refusing to travel to the County Emergency Hospital, upon arrival of the ambulance.

For each accidented person, an diagnosis for inpatient was established. Subsequently, the Office of medical expertise and recovery of work capacity, made a clinical diagnosis for each of them [34].

The cause of the event producing

From the analysis performed on the accident place, but also from the one performed on the documents, including the witness statement, of the photographed evidence, annexed to the research file, the cause of the event producing that took place on 10.10.2018, around 10:45, in which the workers L.I., B.G. and the head of section, engineer R.N., were involved, was due to [34]:

- Failure to comply the instructions for safety at work when checking of the KEG barrels, by the worker L.I. He performed the unthreading of fitting, without having previously performed the pressure removal operation in a bent position above the fitting, in open space and not in the protected space intended for this type of operation. Thus, he exposed to the danger of accident, both his own person and the others involved in the technological process of bottling beer in KEG barrels (Figure 12).

Figure 12. *Photo from the research file / event reconstruction [34]*

- Failure to comply the instructions, the working rules and the safety of the work, when carrying out the transport operations of the KEG barrels, from the band, with the help of the crane, in order to palletize them, by the worker B.G. He got out of control of the barrel he was handling and he was accidented himself;
- Failure to comply of the instructions for work and safety at work when checking the KEG barrels is done, by the Head of Section, engineer R.N. She gave the worker L.I. to carry out the verification of the KEG barrel, leaving him the possibility to understand that maybe perform this check in the place where they are, and not in the specially arranged space.

The provisions of art, 22 and art. 23 paragraph (1) lit. A of the Law on occupational safety and health no. 319/2006, art. 2, art. 3, art. 4 of the instructions for checking of KEG barrels, of the brewery, where the accident occurred, as well as the specific instructions for occupational safety at the operation of KEG barrels checking.

Persons responsible for violating of the legal regulations:

- L.I., as an individual person, is guilty of the findings from chapter (k) of the research report. He did not comply the instructions for work and safety at work when checking of KEG barrels is done;
- R.N., as an individual person, is guilty of the findings in chapter (k) from the research report. It did not comply the labour and occupational safety instructions for checking of KEG barrels. Also, she violated the duties set out in the job description, regarding the service relationships and assigning the tasks to the subordinate employees, on hierarchy way;
- B.G., as an individual, is guilty of the findings in chapter (k) from the research report. He did not comply the instructions and working rules regarding the use and operation of lifting equipment and handling of weights;
- The brewery where the accident took place, as a legal person, is responsible for the findings from the research report. It did not ensure the supervision of the workers' health, by carrying out the periodic medical examination, thus ensuring the implementation of the measures ordered by the labour inspectors.

The contraventional sanctions applied

For the responsibilities established in the research report, it is sanctioned contraventional, according to Law no. 319/2006 of the safety and health at work, the brewery, as a legal person with [34]:
- the amount of 10,000 lei for violating of the provisions of art. 13 letter (n) of Law no. 319/2006 on occupational safety and health, for those found and mentioned in the research report.

Employer who records the accident at work:

According to the stipulations of art. 32 from Law 319/2006 on occupational safety and health, in the context of the accident that occurred on 10.10.2018, the following were found:
- L.I., it is a work accident with disability;
- B.G., it is a work accident;
- R.N., it is a work accident, it will be recorded and statistically reported by the employer.

At the end of the investigation, a plan of measures was established.

CONCLUSIONS

This was a collective labor accident because at least 3 persons were accidented, one of whom was accidented with a disability.[*]

The worker involved in a certain stage of the work process is the one who favors the triggering of the unfortunate event. It is regrettably the fact that a collective work accident was needed, in order to deepen and to investigate the causes, which may trigger such an event.

Through the concept of risk management, it was identified that the triggering factor of the event was constituted by the orders given by the section head. These orders have

[*] For reasons of confidentiality, the name of the employer or of the implied individual persons, there were included in the paper, only initials name, in order to avoid, as far as possible to harm any individual or legal person.

been incomplete, leaving it to be understood that, she wants the immediate fulfillment of the given order, and the respective stage of work, can be carried out under optimal and safe conditions.
The accident investigation activity was carried out by the specialized inspector together with the agreement of those from the event commission (prosecutor, police officer, etc.) was carried out, in order to identify the cause of the event occurrence. Thus, the real cause of the event producing was the neglect of all preventive measures by the employer. It did not fully ensure the safety and health of workers, by the fact that the worker did not receive enough training, especially in the form of information, specific to the workplace. Analyzing the evolution of the event, step by step, it was found that at the brewery where the accident occurred, there was a faulty implementation of risk management.

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