

The organisation as well as the duration of the working time is a factor strongly influencing the industrial accidents. Atypical forms of employment and non-standard work regimes (night work, working on weekends and holidays, etc.) have direct impact on the worker's concentration and performance and can lead to health problems, affect human biorhythm and cause work accidents. Most of the major industrial incidents and accidents have occurred during the night and, in most cases are due to human error. The statistical data shows a higher number of accidents in shift work and night work. The accidents during night shifts are more severe and dangerous. Important factors to the human errors and therefore to the accidents during work are sleepiness, sleep disorders, chronic fatigue and changes in alertness. The changes in the circadian rhythms in combination with the lack of sleep and the chronic fatigue may lead to non-effectiveness on the work place and to decreased productivity as well as to increased risk of accidents.

Objectives:
The main objective of the present study is to assess the relative risk of accidents related

to the working time by analyzing the consequences, the exposure and the likelihood for occurring of these risks. The researchers aim at the assessment of risk factors for accident involvement and accidental injury. Special emphasis is placed on study designs which fit to the available data sources.

Methods:
Statutory in the Republic of Bulgaria the working time is regulated by Directive 93/104/EC transposed to the Labor Code, the Occupational Health and Safety Act and the Regulation No 15 of the terms and requirements for development and implementation of physiological work and rest regimes during work.
For assessing the relative risk of incidents data from a recent study of Folkard and Tucker is used.
Taylor-made statistical tools are presented to enable accident researchers identify whether there is a relationship between a set of potential risk factors and accident involvement or accidental injury.

Results:
Analysis of the data shows that:
- The relative risk of accidents is higher during the afternoon shifts and highest during the night shifts.
- The risk of accidents during night hours is higher in the time period 23.00 h - 01.00 h and 03.00 h - 04.00 h.
- The relative risk increases parallel to the increase of the number of consecutive shifts. It most intensively increases with the increase of the number of consecutive night shifts.
- The duration of the work shift is to great importance for the risk of accidents.

Conclusion:
The construction of flexible shift schedules according to the basic physiological, ergonomic, health and socio-driven requirements can greatly reduce the negative effects of shift work and also can limit the risk of accidents related to the organization of the working time.

Introduction

The organisation as well as the duration of the working time is a factor strongly influencing the production accidents. The contemporary industrial processes, the modern lifestyle and the different economic interests have lead to the fact that many people work on shifts, including night shifts. This type of work organisation is typical for sectors such as health care, transport, processing industry, energy, oils and gas, etc. Atypical forms of employment and non-standard work regimes (night work, working on weekends and holidays, etc.) have direct impact on the worker's concentration and the work environment and can lead to health problems, affect human biorhythm and cause work accidents. Most of the major industrial incidents and accidents in history of mankind have occurred during the night and, in most cases are due to human error. The statistical data shows a higher number of accidents in shift work and night work. The accidents during night shifts are more severe and dangerous. Important factors to the human errors and therefore to the incidents and accidents during work are sleepiness, sleep disorders, chronic fatigue and changes in alertness. The changes in the circadian rhythms in combination with the lack of sleep and the chronic fatigue may lead to non-effectiveness on the work place and to decreased productivity as well as to increased risk of accidents [13, 14].

Methods

Statutory in the Republic of Bulgaria the working time is regulated by Directive 93/104/EC and ILO Convention 171/1990 on night work transposed to the Labor Code, the Occupational Health and Safety Act and State Regulation No 15 of the terms and requirements for development and implementation of physiological work and rest regimes during work.

"Working time" means any period during which the employee is required to perform the work to which he agreed.

"Normal" and "standard" time is considered when:

- ✓ Normal working time is up to 8 hours per day and 40 hours per week;
- ✓ Work week is five days;

"Shift" and "night" work is most often described as work beyond the normal working hours during the day. The term "shift" means time-slots separated at regular intervals for each 24-hour cycle.

Any work performed over the regular working hours is defined as shift work. It includes work on weekends, afternoon shifts, extended shifts, different replaceable/shift modes (rotating, interrupted, continuous and other shifts). Shift work includes all forms of work organization in which the work is carried out in different, changing hours or the work is performed continuously but in unusual work time.

The work shift is mixed when it includes both day and night work. Mixed work shift with four or more hours of night work is considered to be a night and has a duration of night shift, and less than four hours of night work is considered as a day shift and has the length of a day shift.

The night shift usually lasts from 22.00 h to 06.00 h (for juvenile workers from 20.00 h to 06.00 h).

Overtime is any work that is done by an employee outside his normal working hours.

Breaks in the working day are not included in working time and they may not be less than 30 minutes.

In the Bulgarian Labour Code the following issues concerning the working time are regulated:

- Reduced working time;
- Part time work;
- Distribution of working time;
- Irregular working hours;
- Night work;
- Prohibitions on night work and special night work rules;
- Shift work;
- Overtime work;
- Work breaks;

The correlation between the longevity of the work day and the worker's health shows that fatigue increases with the increase of the number of working hours. The industrial traumatism risk is higher in non-standard working hours and includes all forms of work organisation in which the work is performed in different and varying day and/or night hours, or the work is constant but in unusual time for work. Non-standard working hours include shifts work, night work, work during the evenings and the weekends, compressed working hours and every other working hours different from the "normal/standard" ones. The "normal/standard" working hours are defined as the time which is not longer than 8 h per day and 40 h per week, wherein the work is carried out in a period beginning not earlier than 7 h and ending not later than 19 h between the days Monday to Friday.

The standard working hours are in continuous sequence with the exception of the set up breaks.

Taylor-made statistical tools are presented to enable accident researchers identify whether there is a relationship between a set of potential risk factors and accident involvement or accidental injury. For assessing the relative risk of incidents data from a recent study of Folkard and Tucker is used [2].

The main objective of the present study is to assess the relative risk of accidents related to the working time by analyzing the consequences, the exposure and the likelihood for occurring of these risks. The researchers aim at the assessment of risk factors for accident involvement and accidental injury. Special emphasis is placed on study designs which fit to the available data sources.

Results

The present study analyzes the impact of the working time organisation on the health of employees by comparing the subjective opinion of employees about the extent to which their work affects their health and the actual absence from work on annual basis, and in particular the reasons related to the industrial traumatism.

The results of the National Survey of Safety and Health at Work

in 2013 [10] show that more than a third of surveyed employees (39,1%) believe that their work affects their health. To similar conclusions reached also the National Survey of Working Conditions in Bulgaria [8] where 43% of respondents believe the same. As high risk sectors are considered Education (77%), Human health and social work (63%), Processing and production industries and distribution of electricity, heat and gas (about 55%).

What specifically is this influence: 85 % of employees said they had hearing problems under the influence of their work; 22.9% have vision problems; 7% have skin problems; 39.5% experience back pain; 24.5% have a headache; 6.2% - stomach pain; 31.9% - muscle pain in shoulders, neck and limbs; 4.2% had respiratory problems; 3.1% of heart disease, 13.8% suffered injuries; 39.5% experienced stress; 45.4% feel general fatigue; 17.3% have trouble sleeping; 6.2% received allergies; 21.8% experienced anxiety, worry; 20.5% exhibit irritability and temper.

As can be seen, the negative impact of work on workers' health in some ways is quite serious: widespread harmful effects of work are such as general fatigue, stress, back pain, muscle pain, headache, vision problems, anxiety, etc. Much less common are such negative consequences such as hearing problems, skin problems, stomach pain, respiratory problems, heart diseases.

The results reached by the National Survey of working conditions in Bulgaria [10] are similar: around a third of respondents have vision problems, back pain, headache, and muscle aches; 40% complain of stress; more than 60% - of total fatigue; and between 20 and 26 % - from sleep problems, anxiety and irritation.

Analyzing the statistics of the National Insurance Institute [12] on the time at which the accident has occurred related to the working hours we found that the greatest number of accidents occur at the beginning and the end of the working time. The distribution of accidents relative to the day of the week is as follows: the largest number of accidents occur at the beginning of the week, but also during the weekend. Most accidents happen between 9.00 h and 11.59 h in the months of May, June and July. Statistics is listed in the following tables:

Table 1: Time of accident's occurrence related to the working hours [12]

Time of accident's occurrence related to working hours	Accidents				
	2006	2007	2008	2009	2010
Before the beginning of working time	5	0	0	0	0
0 - 1 h. after beginning of work	453	418	422	331	350
1 - 2 h. after beginning of work	522	441	428	370	351
2 - 3 h. after beginning of work	515	482	465	386	319
3 - 2 h. before end of working time	382	418	373	267	264
2 - 1 h. before end of working time	402	369	373	269	278
1 - 0 h. before end of working time	458	432	457	356	323
During other hours of working time	768	763	707	611	558
During breaks	17	14	9	14	14

Table 2: Time of the accident related to week day [12]

Time of the accident related to Week day	Accidents				
	2006	2007	2008	2009	2010
unknown	0	0	0	0	0
Monday	626	628	618	444	432
Tuesday	620	588	565	465	493
Wednesday	656	631	581	438	437
Thursday	641	573	577	478	428
Friday	592	530	528	460	385
Saturday	215	251	212	217	160
Sunday	173	136	153	103	122
During breaks	17	14	9	14	14

Table 3: Time of the accident related to hour of accident's occurrence [12]

Time of accident	Accidents	
	2010	2011
From 10.00 h to 10.59 h	281	290
From 11.00 h to 11.59 h	271	281
From 09.00 h to 09.59 h	258	246
From 14.00 h to 14.59 h	224	235
From 08.00 h to 08.59 h	157	188
From 13.00 h to 13.59 h	189	172
From 15.00 h to 15.59 h	206	160
From 16.00 h to 16.59 h	206	160

Table 4: Month of the accident [12]

Month of the accident	Accidents	
	2010	2011
June	215	242
May	178	233
July	297	225
October	224	211
November	217	207
September	204	202
August	197	185
January	215	184
March	196	183
February	226	173
December	172	173
April	206	166

Regarding the industrial traumatism related to the shift's type, the following results are listed:

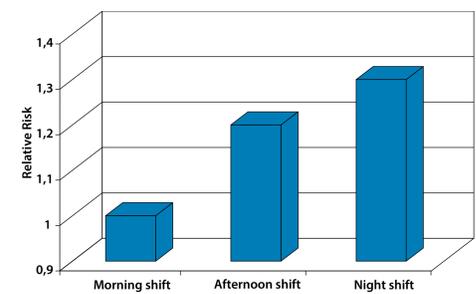
- The relative risk of accidents is higher during the afternoon shifts and highest during the night shifts (Fig. 1).
- The risk of accidents during night hours is higher in the time period 23.00 h - 01.00 h and 03.00 h - 04.00 h.
- The relative risk increases parallel to the increase of the number of consecutive shifts. It most intensively increases with the increase of the number of consecutive night shifts.

The duration of the work shift is to great importance for the risk of accidents.

In the EU member countries there are large differences in the length and organisation of working time. Millions of EU workers work in non-standard hours. According to a study by the European Foundation for Improvement of Living and Working more than 44% of the people work more than 48 hours per week in non-standard working hours. That result adversely affects the state of health and performance of employees. Moreover, the results show that temporary workers are among the most vulnerable as they account for a higher percentage of accidents than other employees.

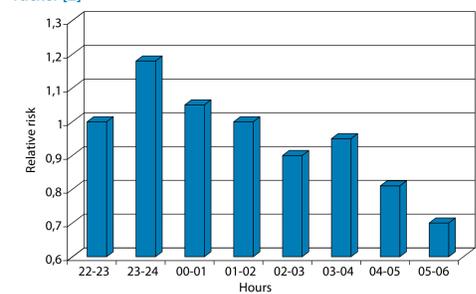
According to results of recent EU studies the relative risk of accidents is higher during the afternoon shifts and highest in the night shifts (Fig. 1) [3, 8]. These data raise the question of the displacement of more dangerous and hazardous work tasks during the morning / day shift and intolerance of isolated work during the night shifts.

Figure 1. Relative risk of accidents at work in shifts according to Folkard and Tucker [2]



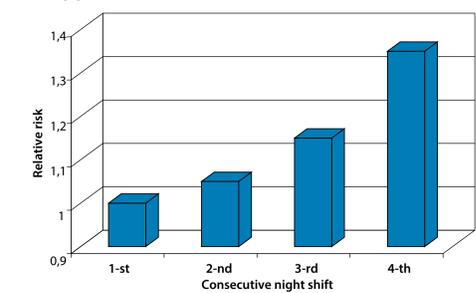
The risk of accidents during night hours is higher in the period 23.00-01.00 h and 03.00-04.00 h (Fig. 2.). It is important to emphasize that the risk of accidents in the first hours of the night shift is higher as the workers are likely to exhibit a lower vigilance.

Figure 2. Relative risk of accidents during night shift, Folkard and Tucker [2]



The relative risk increases with the number of consecutive shifts and primarily, with the number of consecutive night shifts. In Fig. 3 it can be observed an increase in risk by about 6% in the second night shift compared with the first night shift, by 17% in the third, and 36% in the fourth night shift. The European Sleep Research Society recommends that the maximum number of consecutive night shifts should not exceed three. Increase the risk of accidents is also seen with increase in the number of consecutive daily shifts, but the risk is increased to a lesser extent.

Figure 3. Relative risk in consecutive night shifts, Folkard and Tucker [2]

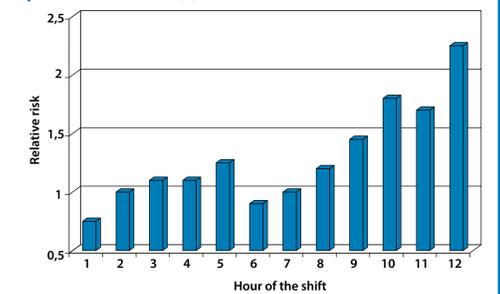


The duration of the work shift is quite an important factor related to the risk of accidents. The studies of Folkard and Tucker [2] show a sharp increase in risk after the tenth hour of the work shift (Fig. 4). Some reduction in risk in the sixth hour of the shift can be explained by the preceding break. At extended shifts Harma [4] finds a 50% increase in the risk after the 11th hour and 100% increase at the of 13th hour.

In Sweden for example, a national survey shows that two years after the introduction of the 12-hour shifts, accidents at work increased 2 times compared with the level in 8-hour shift in the transition period [5].

In developing the shifts regimes it is important to specify if the work task allows extended shifts, given the increasing risk of accidents after the 9th hour of the shift. Extended shifts are allowed only in moderate physical and mental overload and parameters of the working environment within the limit.

Figure 4. Relative risk depending on the duration of the work shift by Folkard and Tucker [2].



General principles of prevention of accidents associated with working time:

- the normal working hours are preferable;
- when the job specifics require non-standard working time, such as shift work, night work, extended work shifts and other, the work schedules must be consistent with good practice [9];
- the statutory breaks during operation, consistent with the given activity, the working conditions, the physical activity and the psycho-social risks are compulsory;
- the non-standard working time must be included in the risk assessment and at identification of risks related to the poor organisation of the working time, proper corrective actions have to be undertaken;
- after a period of time the effectiveness of the corrective actions must be assessed.

Key recommendations for the organisation of the shift schedules [9, 15]:

- the number of consecutive night shifts should not exceed three in number;
- the shift rotation must be clockwise;
- the shift rotation must happen quickly, every 2-3 days for example, and rotation in 1-2 weeks or longer should be avoided;
- the rules for the duration of the shifts must be respected - the 8-hour shifts are preferable and the expended 12-hour shifts have to be avoided;
- the long working periods of more than 48-50 hours per week must be avoided;
- extended shifts have to be allowed only when the physical and mental stress at work is moderate;
- shorter night shifts are preferable;
- night shifts must be shorter than the day and evening shifts;
- repetitiveness of the shift rotation scheme must be ensured.

Findings:

- Analysis of the results gives rise to the following conclusions:
- The relative risk of accidents is higher during afternoon shifts and highest during night shifts.
 - The risk of accidents during night hours is higher in the period 23.00-01.00 h and 03.00-04.00 h.
 - The relative risk increases with the number of consecutive shifts and at first place, with the number of consecutive night shifts.
 - The duration of the work shift is of great importance for the risk of accidents.

Conclusion

The construction of flexible shift schedules according to the basic physiological, ergonomic, health and socio-driven requirements can greatly reduce the negative effects of shift work and also can limit industrial traumatism related to the organization of the working time. The temporary demands for business continuity require the adoption of adequate and flexible organisation of the working time (24 hour work, non-standard hours, including night shifts, extended shifts, weekend work, part-time, flexible working hours, seasonal work, on-call work, etc.). These demands must be synchronized with human's individual preferences, personal interests, life rhythms and needs for nutrition, sleep and rest.

Bibliography:

- Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence; 2014, *Scand J Work Environ Health*. <http://www.ncbi.nlm.nih.gov/pubmed/24100465>.
- Folkard S, Tucker P. Shiftwork, safety and productivity. *Occup. Med.* 2003; 53: 95-101.
- Golden L. The effects of working time on productivity and firm performance: a research synthesis paper; ILO - Geneva 2011; pp. 5-8.
- Harma M. Circadian adaptation to shift work. A review. In: Hornberger S, Knauth P, Costa G, Folkard S. (eds.) *Shift work in 21st Century*. Frankfurt: Petre Lang, 2000: 125-130.
- Harma M. Long work hours - a step backwards? *Tyoterveiset Special Issue*, 1997, pp. 4-6.
- Lee S, McCann D, Messenger J.C., *Working time around the world - Trends in working hours, laws and policies in a global comparative perspective*; 2007, International Labour Office - Geneva.
- Mincheva L, Vangelova K. The night shift work - occupational medicine problems and solutions. *Guidelines*. 2007, Ministry of Labour and Social Policy, Occupational Health and Safety Fund, ISBN 978-954-90826-9-2, Sofia.
- Nakashima M, Morikawa Y, Sakurai M. Association between long working hours and sleep problems in white-collar workers; 2010 European Sleep Research Society. *National Health and Safety Profiles*, 2013 <http://projects.gli.government.bg/index.php?mod=content&show=10>
- National survey of working conditions in Bulgaria, 2012 <https://research.uni-sofia.bg/xmlui/handle/10506/1143>
- Organisation of working time (basic Directive), http://europa.eu/legislation_summaries/other/c10405_en.htm
- Statistical Yearbook "Accidents"; NII, 2014
- Vangelova K. Basic problems and references for the organisation of the work shifts. *Safety and Occupational Medicine* 2006, VIII (2): 53-59.
- Vangelova K. Care for the health of shift workers - an underrated problem of occupational medicine. *Safety and Occupational Medicine*, VIII (4): 45-52.
- Working time in the twenty-first century; International Labour Office - Geneva 2011.