

Causes and consequences of work events in electrical and technical-sanitary installation enterprises from Timis County

Cauze și consecințe ale evenimentelor de muncă în întreprinderile de instalații electrice și tehnico-sanitare din județul Timis

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Abstract. *The paper identifies and hierarchize all factors and causes of work events in the field of enterprises specialized in building facilities and environmental comfort, from Timiș County, considered as integrated part in the process of optimization of specific occupational health and safety risk management systems (OHSRMS). Based on activities (CAEN code 4321 and 4322), the work events from the last 10 years were extracted from official statistics, correlated with number of employees, factors and causes (also, special conditions). 1397 enterprises were selected. The relevance was verified by Fisher test and ANOVA, and possible relations based on work events were identified.*

Key words: work accident/event, optimization, occupational health and safety risk management system

1. Introduction

The technical-sanitary installation industry is usually intensive, and even accident rates in this industry have been steadily decreasing [1], work accidents rate are still higher related to other industries [2]. According to an Eurostat report on total work accidents, 3 355 fatal accidents at work were in the EU during 2020 (for Romania during 2019 a 3,0 incidence rate per 100 000 persons employed), a decrease of 53 deaths compared with the year before [3].

Several studies of root causes were carried out to eliminate fatal incidents in the construction/installation industry [4, 5]. Many studies indicate that such work is not an ergonomics-friendly job, often involving heavy physical labour, unconventional postures, constant bending and reaching movements, unfavourable climatic conditions [6].

Because the most fatal incidents occur during the construction phase, the best way to prevent such incidents was considered to identify their potential occurrence in advance.

The fatal incidents in the construction industry can be identified in advance considering the characteristics of the project.

The main characteristics of construction accidents are the following (7, 8, 9, 10):

- there are various tasks depending on the project type (usually 'all' is a major fatal incident during building/installation construction projects; also 'Traffic accident', and however, 'Overturning the banks of ditches');

- the work is different ('Fall', 'Slip' are major causes of accident; 'Electric shock' is the hazard that should be considered most importantly during electrical work [11];

- the accident type should be subdivided clearly (example: the categories of 'Fall', 'Be hit', and 'Traffic accident');

- in the field of construction/installation, the perception of risk factors at work, almost consequences of accidents, still remaining at low level, [12, 13, 14, 15].

Starting at authors experience in the frame of health & safety work requirements, the paper has the main objective to account and hierarchize the significant work events in electrical and technical-sanitary installation enterprises, in Timiș County, the factors, causes and consequences, considering all actions as integrated parts in the process of assessment and general optimization of specific occupational health and safety risk management systems (OHSRMS).

2. Methods

Starting at specific activity of enterprises (CAEN code 4321 (Electrical works), and 4322 (Plumbing, heating, and air conditioning works)), 1397 enterprises were selected for study.

All the work events from 10 years (2012-2021 year), were extracted from official statistics, in the same time correlated with number of employees, factors and causes (if necessary, special conditions). 12 groups were selected. Based on statistical methods and reports of work events/employee, the groups were evaluated according to the work and healthy risks.

Only enterprises with accidents were considered for statistical analysis. The relevance of results was verified using Fisher test. Possible relations between activities and work events were identified using ANOVA.

Statistical analysis used Microsoft Excel and STATEGRAPHICS Centurion XVI. Conclusions and results of present work were prepared to be generally used in practical optimization of the OHSRMS for improve the conformity with EU and national strategy.

3. Results and discussion

Table 1 presents information collected (enterprises with minimum one accident/year).

Table 1

**Recorded accident in electrical and technical-sanitary installation enterprises, Timiș County
between 2012-2021**

Year	CAEN	Enterprise	Dead			Invalidity			T I W				N	EN
			E	Ad	AR	E	Ad	AR	E	Ad	AR	D		
2012	4322	CASITHERM SERVICE SRL	0	0	0	0	0	0	1	0	0	46	1	16
		CONFORT SRL	0	0	0	0	0	0	1	0	0	55	1	579
		BEMAD YCE SRL	0	0	0	1	0	0	0	0	0	272	1	15
TOTAL c						1			2	0	0	373	3	610
2013	4321	GRUP SIN ELECTRIC SRL	0	0	0	0	0	0	1	0	0	31	1	3
		DEMARK CONSTRUCT SRL	0	0	0	0	0	0	0	0	1	268	1	42
		DEMARK CONSTRUCT SRL	0	0	0	0	0	0	0	0	1	87	1	42
		DEMARK CONSTRUCT SRL	0	0	1	0	0	0	0	0	0		1	42
		COMANDOR SRL	0	0	0	0	0	0	0	0	1	22	1	59
		COMANDOR SRL	0	0	0	0	0	0	0	0	1	45	1	59
TOTAL c					1				1		4	453	6	247
	4322	CONFORT SA	1	0	0	0	0	0	0	0	0	0	1	151
		MI TAM AIR CON- DITIONERS SRL	0	0	0	0	0	0	0	0	1	65	1	12
TOTAL c			1								1	65	2	163
TOTAL y			1		1				1		5	518	8	410
2014	4321	SC ELECTRIC SG INSTAL SRL	0	0	0	0	0	0	0	1	0	15	1	8
		SC MELBO INSTAL SRL	0	0	0	0	0	0	1	0	0	38	1	34
		SC COMANDOR SRL	0	0	0	0	0	0	1	0	0	51	1	58
TOTAL c									2	1		104	3	100
2015	4321	LOGIMAETICS ELECTRIC SRL	0	0	0	0	0	0	1	0	0	86	1	31
	4322	FLEXIK AUTOMATION SRL	0	0	0	0	0	0	1	0	0	60	1	207
		TERMODINAMICA SRL	0	0	0	0	0	0	1	0	0	3	1	16
TOTAL c									2			63	2	223
TOTAL y									3			149	3	254
2016	4322	HIDROPLUS SRL	0	1	0	0	0	0	0	0	0		1	14
		DINU INSTAL SRL	0	1	0	0	0	0	0	0	0		1	46
		AGASI SRL	0	0	0	0	0	0	1	0	0	24	1	157
		RADEL & HAHN SRL	0	0	0	0	0	0	1	0	0	14	1	30
		MI TAM AIR CON- DITIONERS SRL	0	0	0	0	0	0	1	0	0	90	1	15
		AGASI SRL	0	0	0	0	0	0	0	1	0	24	1	157

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		AGASI SRL	0	0	0	0	0	0	1	0	0	148	1	157
TOTAL c				2					4	1		300	7	576
2017	4321	ELECTRO BENCONS SRL	0	0	0	0	0	0	1	0	0	180	1	21
		GLOBAL SOLUTIONS SRL	0	0	0	0	0	0	0	0	1	31	1	14
		GLOBAL SOLUTIONS SRL	0	0	0	0	0	0	0	0	1	82	1	14
TOTAL c									1	2		293	3	49
	4322	PIPETECH SRL	0	0	0	0	0	0	1	0	0	152	1	13
TOTAL c									1	1	2	445	4	62
2018	4322	ROLIFT SERV SRL	0	0	0	0	0	0	1	0	0	24	1	5
TOTAL c									1			24	1	5
2019	4322	RADEL & HAHN SRL	0	0	0	0	0	0	1	0	0	59	1	27
		DISTRI-REVIZII-VERIFI-CARI DPM S.R.L.	1	0	0	0	0	0	0	0	0	0	1	2
		DINU INSTAL SRL	0	0	0	0	0	0	1	0	0	47	1	34
		AGASI SRL	0	0	0	0	0	0	1	0	0	32	1	147
TOTAL c			1						3			138	4	210
2020	4321	ELECS MONTAJ S.R.L.	0	0	0	0	0	0	1	0	0	17	1	13
		CONS ELECTRIFICAREA INSTAL SRL	0	0	0	0	0	0	0	0	1	51	1	115
		DANNYS-M.D. SRL	0	0	0	0	0	0	1	0	0	5	1	12
TOTAL c									2		1	73	3	140
2021	4321	GLOBAL SOLUTIONS SRL	0	0	0	0	0	0	1	0	0	72	1	13
	4322	INSTGAT SRL	0	0	0	0	0	0	1	0	0	12	1	51
TOTAL y									2			84	2	64
TOTAL P			2	2	1	2			21	3	8	2208	38	2431

In table 1, the significance are: E – accidents caused by the employee; Ad - accidents caused by administration or responsible work safety; AR – accident on road from/to workplace; D – days of temporary inability; N – number of accidents cumulated on enterprise/year; EN – employee’s number/year; TOTAL c– total on activity’s code; TOTAL y – total on year (more cods); TOTAL P – total for all considered activities and years (panel).

Analyzing processed data Microsoft Excel, next conclusions could be formulated:

- In the analyzed period both groups of activity generated work accidents, with small differences between groups (17 versus 21);

- The results used in statistic were calculated at 1000 employees according to actual used solutions [16].

The first analysis studied the character of relationship between number of accidents on year, N, and number of employees NE, starting at simple regression considering relevant S-curve model ($Y = \exp(a + b/X)$). (Such model was considered adequate after linear or/and nonlinear models were tested). Here Y is total yearly number of accidents (column N at rows TOTAL y in table 1), and X is the total

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number of employees (NE, in same conditions). The results of STATGRAPHICS indicated the optimum equation of the fitted model:

$$N = \exp(1.37568 - 7.10394/NE) \quad (1)$$

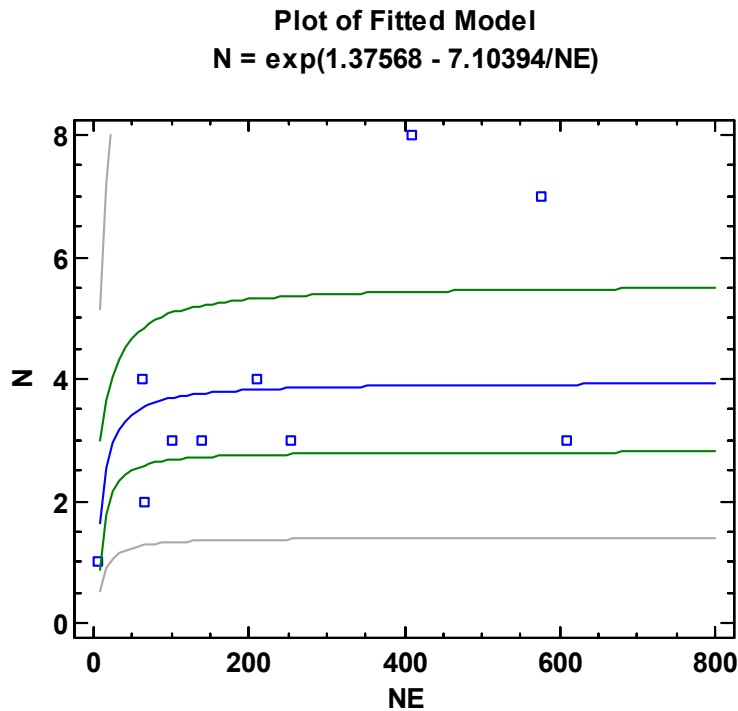


Fig. 1 The plot of fitted model for function $N=f(NE)$

Table 2

Results for coefficients and analysis of variance for function $N=f(NE)$

Coefficients

	Least Squares	Standard	T	
Parameter	Estimate	Error	Statistic	P-Value
Intercept	1.37568	0.146888	9.36553	0.0000
Slope	-7.10394	2.30229	-3.0856	0.0150

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	1.70407	1	1.70407	9.52	0.0150
Residual	1.43185	8	0.178982		
Total (Corr.)	3.13592	9			

In Figure 1 can be seen the position in graphic and in Table 2 the results for coefficients and analysis of variance. The R-Squared statistic indicates that the model

as fitted explains 54.3402% of the variability in N. The correlation coefficient equals -0.737158, indicating a moderately strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 0.423062. The mean absolute error (MAE) is 0.30368. Since the P-value is greater than 0.05, there is no indication of serial autocorrelation in the residuals at the 95.0% confidence level.

Regarding the possible relationship between number of days of temporary inability, D, and number of employees NE, in Fig. 2 can be seen the plot of fitted model in graphic and in table 3 the results for coefficients and analysis of variance in the same conditions of regression.

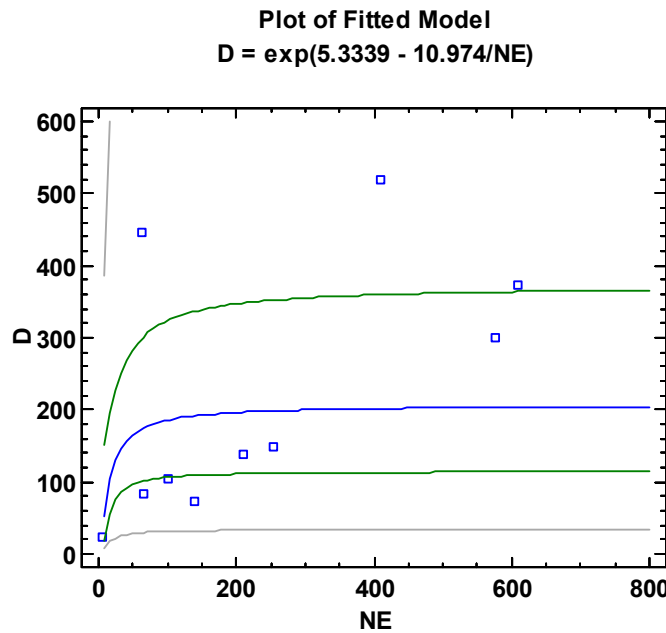


Fig. 2 The plot of fitted model for function $D=f(NE)$

Table 3

Results for coefficients and analysis of variance for function $N=f(NE)$

Coefficients

	<i>Least Squares</i>	<i>Standard</i>	<i>T</i>	
<i>Parameter</i>	<i>Estimate</i>	<i>Error</i>	<i>Statistic</i>	<i>P-Value</i>
Intercept	5.3339	0.254694	20.9424	0.0000
Slope	-10.974	3.99203	-2.74898	0.0251

Analysis of Variance

<i>Source</i>	<i>Sum of Squares</i>	<i>Df</i>	<i>Mean Square</i>	<i>F-Ratio</i>	<i>P-Value</i>
Model	4.06647	1	4.06647	7.56	0.0251
Residual	4.30492	8	0.538115		
Total (Corr.)	8.37139	9			

The results shows the results of fitting a S-curve model to describe the relationship between D and NE. The equation of the fitted model is

$$D = \exp(5.3339 - 10.974/NE) \quad (2)$$

Since the P-value in the ANOVA table is less than 0.05, results a statistically significant relationship between D and NE at the 95.0% confidence level. The R-Squared statistic indicates that the model as fitted explains 48.5758% of the variability in D. The correlation coefficient equals -0.696964, indicating a moderately strong relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals is 0.733563. The mean absolute error (MAE) is 0.583515. Because P-value is greater than 0.05, there is no indication of serial autocorrelation in the residuals at the 95.0% confidence level.

4. Conclusions

The obtained results justify once again the necessity to extend health and safety measures in the technical-sanitary installation industry and continuous improvement of occupational health and safety risk management systems, because, opposite to present measures, the work is still usually intensive, and even accident rates in this industry have been steadily decreasing, work accidents rate are still higher related to other industries (The present statistics demonstrated an average about one day of temporary incapacity of work/employee/year!). A special mention was justified for enterprise less than 50 employees (micro and small enterprises), when the number of work accidents is dependent of number of employees. If the number of employees is greater than 100, the number of work accidents keep the same. All hypothesis from introduction were demonstrated.

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