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ANALYSIS OF USE OF SELECTED IT TOOLS IN WORK SAFETY MANAGEMENT

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Dynamic development of IT tool applications is observed in all areas of management. This paper chiefly identifies work safety management areas in which information technology tools are currently used. At the same time, it reviews IT tools that are most frequently used for areas identified in the context of solving specific safety problems. Based upon analysis of test results, it evaluates the use of selected IT tools in the group of small and medium manufacturing companies.

Keywords: IT tools, occupational Safety management

1. Introduction

On one hand, information technologies constitute a set of processing methods and tools, which includes methods of information acquisition, selection, gathering, recording, storing, processing and transferring or removing. On the other hand, it comprises all technical activities related to manners of designing architecture and production of technical information resources [6]. Information technology is also a combination of computer science technologies with other associated technologies, in particular with communication technologies, whereas computer science technology is a technological application of information technology within the society, i.e. also in its organised forms, such as companies.

Information technology systems and tools play an increasingly significant role in management processes used no manage not only particular companies [1, 13, 16, 17], but also entire supply chains [8].

Management supporting computer systems improve operational efficiency of companies [9, 11], in particular in the area of logistics [4, 10] by supporting information exchange both inside the company [12] and outside it [3]. Equally important are business-specific applications in the form of e.g. virtual laboratory [15] or applications used in reverse logistics [5].

Furthermore, such state-of-the-art solutions as *Business Intelligence* and *Cloud Computing* [14], are increasingly often used, also in small and medium businesses [2].

To sum up, it can be said that information technologies perform two basic functions in companies: the innovative function and the services-providing function. The innovative function creates new opportunities of development, which would have been impossible without the use of IT, while the services-providing function allows the company to more effectively perform its activities in various areas, especially through process automation and speedup. In this area, an important role is played by software.

2. Review of IT tools in basic work health and safety areas

Possibilities of using computer technologies to support work safety management are highly varied, and computer programmes constitute indispensable tools used in various work health and safety areas.

Basic software groups, which are most frequently used in the area of work health and safety management in organisations, comprise: work safety management in a systemic perspective, analysis of broadly comprehended (accident and illness) risks, analysis of reasons for accidents and near-misses (taking into account varying levels of detail in such an analysis) and the hygiene of work. Thematic databases and the Internet are also commonly used due to a large number of governmental and free-of-charge websites dedicated to theoretical and practical aspects of providing for safe and healthy conditions of work in organisations of varying types and with varying operational specifics.

The group of programmes dedicated, broadly speaking, to work safety management primarily includes programmes used to support planning and monitoring activities connected with work safety systems. These are the programmes that are above all used for control and assessment of work safety management system by using audits, for employee health monitoring, for hazard identification and risk management, for preparing emergency plans for disasters, as well as for planning and monitoring work health and safety training programmes.

The second vast group covers risk assessment programmes using such methods as: fault trees, event trees, HAZOP or WHAT-IF, as well as programmes used to simulate accident scenarios.

The next group is the group programmes used to review reasons for accidents and near-misses based upon accident emergence model we adopted. This group comprises programmes used to review reasons for failures and defining methods to remove them, programmes used to record accidents and accident statistical analysis programmes, as well as special expert systems used to analyse reasons for accidents.

The last vast group of programmes includes tools used to evaluate employee health exposure to some determined hazard types, and to select optimum solutions aimed at improving conditions at work, i.e. focused at proper hygiene of work, e.g. by indicating the most appropriate personal protection equipment. Programmes within this group primarily pertain to the analysis of noise-related hazards, manual transport works, loads on the human locomotor system parts, various types of radiation, microclimatic conditions, as well as health hazards caused by stress at work. Examples of software concerning work health and safety areas being discussed here are listed in Table 1 and 2.

Table 1. Examples of work safety software (listed alphabetically) – section 1

Topics	The program name and producer
Analysis of health hazards in the case of handwork and transport	ErgonLIFT (IfADo, Grmany)
Analysis of health risks in the case stress and burden movement organs	Desk Dokter (Uitgeverij Kerckebossch, Netherlands)
Analysis of noise in the workplace	SOUNDCALC (ARBOSOFT, Netherlands)
Analysis of radiation exposure	PCCOSYMA (EC, Belgium
Analysis of the risks of explosion and fire	Spectrum (Battelle Process Risk Management Services, USA)
Expert systems to study the causes of accidents	REX-SAMAN (Rodan Telecom, Poland)
FMEA (Failure Mode and Effects Analysis) FMECA (Failure Mode, Effects and Critical Analysis Processor)	FMECA, ProFMEA (Advanced Logistics Developments, USA)
Hazard identification and risk management	RAMS (DELTASOFT Ltd., England)
Modelling the potential impact of threats	ATMS (Ebasco Environmental, USA); COLLIDE (Dove Safec AS, Norway); DISMA (TUV Ostdeutsschland, Germany); Sofia (SOFRETEN, France)

Source: own preparation on the basis [7]

Table 2. Examples of work safety software (listed alphabetically) – section 2

Monitoring and evaluation work safety management system (Audits)	Flowcharting (Conger & Elsea, USA)
Monitoring the health of workers	CamHealth (CamAxys Ltd., England), CHAOSS (ICL, England)
Planning and monitoring of work safety management	S-CHASE (HASTAM, England); MANAGE-PC (PrimaTech Inc., USA); REX-SAMAN (Rodan Telecom, Poland); Safety Auditor (ErgoSystems Ltd., England)
Probabilistic risk analysis methods, mathematical and statistical	FRA NTIC ABC, RiskCalc (Applied Biomathematics, USA)
Registration accidents and their statistical analysis	ACCIDENT (ARBOSOFT, Netherlands); UNAP (Machinenbau und Metall Brufsgenossenschatf, Germany)
Registration and analysis of the causes of accidents	Microsafe (Bowring Protection Consultans, England); PERSIST (NIA, Netherlands); SAFEGUARD (Cypher Information Systems, England)
Research microclimate conditions in the workplace	CLIMCALC (ARBOSOFT, Netherlands)
Research the causes of failure and methods of their removal	v-FRACAS Failure Reporting and Corrective Action System (Advanced Logistics Developments, USA)
Risk analysis using the event tree	Events & Casual Factors (Conger & Elsea, USA); Risk Spectrum (RELCON, Sweden); HAZOPimizer (Arthur D. Little, USA); PAPA (Taylor Associates Aps, Denmark), PHA Works (PrimaTech, USA)
Risk analysis using the fault tree	FaultrEASE (Arthur D. Little, USA); Fault Tree Analysis (Conger & Elsea, USA); Fault Tree Manager (AEA, England); PRE-EASE (Dovre Safe AC, Norway); Risk Spectrum (RELCON, Sweden); SAFETY Monitor Software (NUC Corporation, USA)
Simulation of accident scenarios	EFFECTS, GasMal P (TNO, Netherlands; COPRO, Poland)
Technical safety management	CB-Prisma (ClassBase Software, Netherlands); V-CARE (BQR Reliability Engineering Ltd., Israel)

Source: own preparation on the basis [7]

Most frequently used databases primarily comprise information upon legal regulations, both domestic and international, upon chemical products, upon literature thematically related to work safety, upon standards, licences and certificates in this area, as well as information concerning serious accidents and failures. Examples of databases are listed in Table 3.

Whereas Table 4 lists examples of work safety web information sources offered by governmental organisations or various kinds of associations.

Table 3. Examples of work safety databases (listed alphabetically)

Topics	The database name and producer
Accidents and failures	FACTS (TNO, Netherlands); EIDAS, MHIDAS (AEA, England); MARS – Major Accident Reporting System (Joint Research Institute ISPRA, Italy)
Chemical products	CHEMINFO, CHEMSource, HSBD – Health and Safety Toxic Effects (CCOHS, Canada); CHEMLIST (ARBOSOFT, Netherlands); ED40 Database (DMSO Publication Center, England); IRIS (EPA, USA)
Regulations	ChemADVISOR (CCOHS, Canada); EHAS (EHAS, England); EuroOSH (Chapman& Hall, England); ICRMS (Ariel Research Corporation, USA); Lex (Wydawnictwo Prawnicze Lex, Sp z o.o., Poland)
The literature on work safety	ARBOSOFT (ARBOSOFT, Netherlands); OSH InterData (CCOHS, Canada)
The standards, licenses, certificates	SHE (Atlas International Computing Services Ltd., England)

Source: own preparation on the basis [7]

Table 4. Examples of work safety web information sources (listed alphabetically)

Source	Name Website
Advanced Chemical Safety, Inc.	http://www.chemical-safety.com./
American Chemical Society Division of Chemical Health and Safety	http://www.dchas.org/
China Academy of Safety Science and Technology	http://www.chinasafety.ac.cn/
Health and Safety Executive	http://www.hse.gov.uk/
International Labour Organization Social Protection	http://www.ilo.org/safework/
International Programme on Chemical Safety	http://www.aho.int/ipcs/en/
Occupational Safety and Health Administration, US	http://www.osha.gov/
Occupational Safety and Health Association, China	http://www.cosha.org.cn/
Occupational Safety and Health Council, HK	http://www.oshc.org.hk/
Safe Work Australia	http://www.safeworkaustralia.gov.au/
State Administration of Coal Mine Safety, China	http://www.chinacoal-safety.gov.cn/
State Administration of Work Safety, China	http://www.chinasafety.gov.cn/
The American Industrial Hygiene Association	http://www.aiha.org/
The American Society of Safety Engineering	http://www.asse.org/
The Canadian Centre for Occupational Health and Safety	http://www.ccohs.ca/
The Safety Association for Canada's Upstream Oil and Gas Industry	http://www.psc.ca/

3. Research methodology

This paper is based upon test results from tests conducted in 97 small and medium manufacturing businesses in southern Poland (mainly the Province of Silesian). Small businesses, i.e. the ones that employed from 10 to 49 employees inclusive (53.61%) constituted the majority of the group examined. Medium businesses, i.e. the ones that employed from 50 to 250 employees inclusive, constituted the remaining part. Micro enterprises were not tested. The research was carried out using the questionnaire method in January 2014, and years 2011-2013 were surveyed. Questionnaires were delivered to random selected companies. Filling in a standard "name plate" including basic company data (name, main seat of business, employment, legal form, etc.) was a condition for the questionnaires to be accepted for further processing. The statistical data we obtained was processed using the STATISTICA software in the quantitative and qualitative aspect. Basic statistical measures were used to perform the statistical analysis, and a non-parametrical equivalent of the single variant analysis, Kruskal – Wallis test, supplemented by the median test, was used to verify the initial hypotheses we had adopted. The objective of this research was to find an answer to the question whether or not there was any difference in using selected work health and safety information tools in manufacturing companies of varying sizes. The analysis was based on the following six basic groups of tools: M1 – hazard identification and risk management tools, M2 – work health and safety management system control and assessment tools (audits), M3 – employee health monitoring tools, M4 – training planning and monitoring tools, M5 – disaster emergency planning tools and M6 – statistical analysis and accident recording tools.

4. Utilization rate of selected IT tools in the area of work health and safety

The companies we reviewed evaluated their utilisation rates of information tools divided to six basic groups, using a five-point scale from 1 – "not used" to 5 – "used systematically". Table 5 lists basic statistical values that characterise the reviewed group of 97 small and medium manufacturing companies for using the information tools that support work health and safety management as discussed here.

The list suggests that the companies we reviewed relatively gave the highest grade to their utilisation rate of hazard identification and risk management tools (A = 2.41), most probably because these tools pertained to their basic and mandatory actions. On the other hand, the lowest grade was given by them to their utilisation rate of statistical analysis and accident recording tools (A = 2.00), probably because they failed to notice the need to perform such actions in the context of the obligation to draw up statistical accident charts.

Table 5. Statistics of utilisation rate of work health and safety information tools in the reviewed group of 97 small and medium manufacturing companies

	% of companies with grade							
	1	2	3	4	5	A	ST DEV	VAR
Hazard identification and risk management tools (M1)	17.53	42.27	26.80	8.25	5.15	2.41	1.04	1.08
Work health and safety management system control and assessment tools (audits) (M2)	11.34	36.08	43.30	9.28	0	2.51	0.82	0.67
Employee health monitoring tools (M3)	9.28	47.42	38.14	5.15	0	2.39	0.73	0.53
Training planning and monitoring tools (M4)	15.46	48.45	29.90	5.15	1.03	2.28	0.83	0.68
Disaster emergency planning tools (M5)	16.49	43.30	34.02	6.19	0	2.30	0.82	0.67
Statistical analysis and accident recording tools (M6)	26.80	49.48	20.62	2.06	1.03	2.00	0.81	0.66
A – Average; ST DEV – Standard Deviation; VAR – Variance Grading scale: 1 – not used; 2 – very rarely used; 3 – sometimes used; 4 – frequently used; 5 – used systematically								

5. Size of a company and utilization rate of work health and safety information tools

The following initial hypotheses were adopted, which assumed that there was no statistically significant difference in utilisation rates of selected work health and safety information tools, in the group of small companies and in the group of medium companies. Alternative hypotheses assumed that there were some statistically significant differences with this respect. Table 6 lists results of the analysis of variance for the adopted dependent variables M1 – M6 as well as for the "company size" grouping variable.

The analyses obtained suggested that for the adopted materiality level $\alpha = 0.05$, the initial hypotheses we adopted should be refuted in case of usage of work health and safety management system control and assessment tools (M2), employee health monitoring tools (M3), and disaster emergency planning tools (M5). In case of these dependent variables, the probability level for the Kruskal-Wallis test, and for the chi-square test, was much lower than the adopted materiality level α, which meant that there was a statistically significant difference between utilisation rates of these three groups of tools in companies of various sizes.

Table 6. Results of non-parametrical single variant analysis for the examined dependent variables and the "company size" grouping variable

Non-parametrical statistics for multiple independent groups Significance level α = 0.05; Grouping variable: „company size"						
Group 1: small enterprises (10-49 employees) Group 2: medium enterprises (50-250 employees)						
Dependent variables	M1	M2	M3	M4	M5	M6
ANOVA Kruskal – Wallis range						
Sample size of group 1	52	52	52	52	52	52
Rang sum of group 1	2724.5	2225.0	2189.0	2653.0	2214.0	2621.5
Sample size of group 2	45	45	45	45	45	45
Rang sum of group 2	2028.5	2528.0	2564.0	2100.0	2539.0	2131.5
H – Kruskal-Wallis test value	1.8128	6.2775	8.0575	0.6741	6.6729	0.3322
p – Probability level for the above value of test H	0.1782	0.0122	0.0045	0.4116	0.0098	0.5643
Median test						
Total median	2.00	2.00	2.00	2.00	2.00	2.00
Chi-square	4.4721	11.463	7.1676	0.2750	8.2264	0.1029
df – Number of test freedom degrees	1	1	1	1	1	1
p – Probability level for the above value of Chi - test	0.0345	0.0007	0.0074	0.5999	0.0041	0.7484
Explanations M1-M6 as shown in Table 4.						

On the other hand, in case of the remaining dependent variables, the probability level for the Kruskal-Wallis test was higher than the adopted materiality level α. Hence, it could be assumed that there was no statistically significant difference in utilisation rates of hazard identification and risk management tools (M1), training planning and monitoring tools (M4) and statistical analysis and accident recording tools (M6) in the reviewed group of small companies and in the reviewed group of medium companies.

6. Summary and conclusions

Dynamic development of IT tools we have observed in recent years has also been mirrored in the area of work health and safety management.

Construction of information system management depends on the adopted model of managing health and safety, for example by ILO2001, OHSAS or BS8800 (and others). The model focuses on specific areas of health and safety, and thus obtained a variety of data and information. Depending on the approach to safety by measures taken by the company may be ad hoc, systematic, systemic and

proactive, which influences the choice of tools in terms of area and severity of these tools. On the other hand, depending on the level of management maturity (as a whole) in the company, reports and results may vary in scope and form.

In addition, system solutions can be dedicated to particular industries and even companies. Tools used in areas such as risk assessment and investigation of accidents and disasters, are particularly varied due to the different definition of the concept of risk (including differences in parameters and measurements) and a multitude of models, techniques and tools for examination of various kinds of accidents and disasters, in various industries.

Basic software groups used in companies in the area of work health and safety comprised: work safety management in a systemic perspective, risk assessment, analysis of reasons for accidents and near-misses, and the hygiene of work.

Based upon analysis of test results, it was found that the size of a company exerted an impact upon utilisation rates of programmes in the group of work health and safety management system control and assessment tools, employee health monitoring tools, and disaster emergency planning tools. This primarily results from the fact that control and assessment of work health and safety management systems, in practice, only refers to companies that have their systemic work health and safety solutions in place, which is still not very widespread; employee health monitoring is most frequently outsourced to external companies, and the need to devise disaster emergency plans is not fully recognised yet, especially within the group of small companies.

In case of the group of small and medium companies, an especially beneficial solution is offered by free-of-charge *open source* software and systems, as they significantly raise utilisation rates of information tools in other areas of management; and so they could improve this company group's results in the area of work health and safety management as well.

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