

JOSIP TARADI¹
ZDRAVKO KRAKAR²
VESNA NIKOLIC³

¹University College of Applied
Sciences in Safety, Zagreb

²University of Zagreb, Faculty of
Organization and Informatics,
Varaždin

³University of Niš, Faculty of
Occupational Safety, Niš

¹josip.taradi@vss.hr

²zdravko.krakar@foi.hr

³vesna.nikolic@znrfak.ni.ac.rs

MODEL OF OCCUPATIONAL INJURY INFORMATION SYSTEM AND KNOWLEDGE MANAGEMENT

Abstract: The aim of the research, which was accomplished in the process of research is the establishment of a comprehensive and consistent model of occupational injury information system and knowledge management, thus creating a precondition for the improvement of occupational safety system. Theoretically and practically applicable model of occupational injury information system and knowledge management has been established on the basis of the re-engineering of information processes of occupational injury reporting and analysis and the possibility of application of modern information and communication technology, especially the Internet. The integrity of the model is verified through simple inclusion of all elements, participants and other stakeholders as well as the general public in the system. The consistency of the model is confirmed by the uniqueness of occupational injury information system and knowledge management.

Key words: information system, knowledge management, model, occupational injury, occupational safety

*"Information and knowledge are the thermonuclear competitive weapons of our time."
Tomas A. Stewart*

INTRODUCTION

Subject matter of research

Information can be viewed from different aspects, from the broadest philosophical to the narrow technical aspect, or in terms of information and communication technology [1]. Information is the result of data processing [2]. As a central concept in the information science it implies as a certain amount of knowledge needed for a particular procedure, which is specifically not available. Thus, the information can be defined as "knowledge in action" but also as "the basic foundation for learning."

Information flow of the learning process begins with the analysis of the input information in relation to prior knowledge and set goal and by reaching the conclusion thus creating new knowledge or a better form of prior knowledge. New knowledge can be obtained from the environment or can be produced by deduction, induction or analogy. Information management is the process of converting information into knowledge through permanent storage of information. It is therefore necessary to comprise (what is technically a formal procedure) and organize (a procedure related to the content - the level of semantics) knowledge [3].

By the definition of the International Federation for Information Processing (IFIP), "an information system is a system that collects, stores, keeps, processes and delivers information relevant to the organization and society, so that they are accessible and usable for anyone who wants to use them, including management,

customers, personnel and others." The importance of strategic management decisions concerning the information system is reflected in helping organizations to "capitalize on IT opportunities". The key decisions of information system strategic management include: reengineering, outsourcing, the legacy of the existing system, user/server architecture, group work, system integration and the Internet and new technologies [4]. According to [5], basic elements of the information strategy management are: information strategy analysis and strategic choice. Information systems must support business operations at all levels of management and strive to integrate all business functions and processes thus creating a unique "managerial information system", which connects transactional information systems with the lowest data level with information systems of higher levels for decision support and knowledge-based expert systems in modern "digital enterprises" [6].

According to [7], knowledge management is a "new opportunity level of the upcoming information technology" and it is manifested as an "effective realization, implementation and maintenance of organizational knowledge and collaborative business environment enabled by the application of advanced information technology, tools and methods." Unfortunately, the literature has not still provided universal and uniform definitions of knowledge management, thus it is advisable to observe this concept in a broader context" as a process through which an organization generates value of their intellectual property based on knowledge" [8]. To "generate" actually means to share knowledge among employees, departments and even other companies if that is in the interest of best results and practices. At the same time, the technology facilitates the application of

knowledge management, but it does not constitute knowledge management.

Besides technology, knowledge management involves people and processes as interconnected and overlapping parts with the ultimate goal of effective application of knowledge in decision-making situations. Hence the concept of knowledge management can be seen as "the ability to reach an information in a relatively short time that will enable everyone in the organization to make the best decision, whether it relates to market conditions, product, service, process, planned activities of competitors, or some other information (occupational safety, prim. aut.) important for the success of the company [9].

According to [10], "occupational protection is a state which allows for a normal flow of business processes and functioning of business systems, and thereby better business results." Occupational protection can be achieved by implementing occupational safety policies and measures, provided that the necessary knowledge is acquired. Petersen [11,12,13,14] links scientific methods and managerial techniques to create 'safety management techniques' and based on the 'goal-oriented safety management concept' for the purpose of performing a 'safety system effectiveness analysis' in accordance with the laws of economy and principles of management establishes 'standards for monitoring safety system performance'.

Occupational injury data are key performance indicators used to measure safety in business systems, industry branches, regions and countries. The analysis of occupational injury data is a precondition for acquiring knowledge and developing new occupational safety rules [15, 16].

Upon analyzing the procedure followed in occupational injury reporting in Croatia, [17] have concluded that 'the computerization of the occupational injury recording and reporting system will set the basic preconditions for ensuring good data quality and reliable medical statistics'. After gathering and measuring such data, problems will be more detectable and it will be easier to intervene in the working process in order to prevent occupational injuries based on the acquired data [18, 19, 20]

That is exactly why the existing system of occupational injury recording and reporting in the Republic of Croatia requires urgent modification.

Research problem

A problem of the incompleteness and inconsistency of occupational health and safety information systems and knowledge management can be identified, which is neither in compliance with theoretical (scientific) settings of information systems and knowledge management, nor with possibilities of the contribution of modern information and communication technology. That is the issue of business system management, but also of the overall occupational safety system in Croatia.

Objective

The research aims to contribute to the improvement of occupational health and safety system by modelling a comprehensive and consistent, science-based model of occupational health and safety information systems and knowledge management.

MODEL OF OCCUPATIONAL INJURY INFORMATION SYSTEM AND KNOWLEDGE MANAGEMENT

Systems analysis of occupational safety system

Systems analysis of occupational safety system is based on: 1) theoretical (scientific) bases of occupational safety and its organization, 2) normative (legal) bases of the organization of occupational safety, and 3) occupational safety practice analysis.

Systems analysis of occupational safety system is based on: 1) theoretical (scientific) bases of occupational safety and its organization, 2) normative (legal) bases of the organization of occupational safety, and 3) occupational safety practice analysis.

The function of the system (F) incorporates the meaning of existence, goal, purpose and role of the system. The function of occupational safety system can be defined as the purpose of occupational health and safety, which is preventing work-related injuries (including prevention of occupational diseases and other work-related illnesses) and protecting working environment, with the aim of achieving maximum safety as a condition for normal operation of business systems and the entire social community. The basic function of occupational safety system is prevention.

Decomposing the system reveals three main subsystems (as organizational subsystems) of occupational safety systems with regard to their role and area of responsibility in the area of occupational safety system, including:

- 1) National subsystem of occupational safety system.
- 2) Business subsystem of occupational safety system.
- 3) Public subsystem of occupational safety system.

The first (micro) level of occupational safety system management is achieved in the business sub-system of occupational safety system. This level is a central and key management level, because occupational safety is directly realized in the business system and business system management is responsible for the implementation of occupational health and safety, but also for the consequences of occupational injuries.

On the principles of systems and process approach, it is possible to decompose the occupational safety system from the perspective of the system management, as follows: management function (subsystem, a set of processes) → process (a set of actions and decisions) → activity (process step, action). This way three subsystems of management functions can be determined, including:

- 1) subsystem of occupational risk management,
- 2) subsystem of occupational health and safety management, and

3) subsystem of occupational injury management.

These managerial subsystems are interconnected by direct sequential links. The first level of occupational safety system management includes reciprocal links to all subsystems individually. Backlink between the subsystem of occupational injury management and the subsystem of occupational risk management that closes the system in a constant reversible cycle and provides necessary information and new knowledge for occupational risk assessment audit after which new occupational safety measures are established, is of key significance in order to accomplish the objective of occupational safety system (constant improvement of the system by preventing occupational injuries). Based on that, a mathematical model of occupational safety system can be set, defined by the following formal expression:

$$S = \{R, Z, O\} \quad (1)$$

S – occupational safety system management, R – subsystem of occupational risk management, Z – subsystem of occupational health and safety management, O – subsystem of occupational injury management.

Data model in the existing occupational injury information management system

Data model can be established based on data analysis in the existing occupational injury information management system. While the analysis was based on the existing documents containing specified information relating to occupational injuries occurring in the business subsystem of occupational safety system, general (conceptual) model contains a graphical representation of groups (classes) of data from these documents and relationship of data on occupational injuries in the business system (Figure 1). The following main groups of data can be extracted from the total documentation system:

- 1) data on the employer (business system),
- 2) data on the injured employee (employees),
- 3) data on occupational injury,
- 4) data on the implementation of occupational safety measures,
- 5) data on the manager of operations during which injury occurred,
- 6) data on occupational injury eyewitnesses,
- 7) data on occupational injury examiners,
- 8) data from occupational medicine and doctors on occupational injury,
- 9) data from the Croatian Institute for Health Insurance,
- 10) data on the costs of occupational injuries,
- 11) other occupational injury data.

The model clearly shows that the key data are generated during the process of occupational injury examination and recorded in a document entitled "Record of occupational injury examination". Other processes and their supporting documents use only these original data on occupational injury. Exceptions are the processes and reports on occupational injury and occupational injury cost calculation, which are

using data generated from external systems or other internal systems in the business system.

Detailed analysis of the data shows:

- a) Data incompleteness - because not all required data are included.
- b) Data inconsistency - because time and logical and hierarchical relationships between data are inconsistent, along with the existence of discrepancies between data links.
- c) Data redundancy - because data are repeated (copied) in the processes and documents.

In addition, data analysis shows irregularities in the classification and structure of data in the required documentation, which prevents direct application in the database. The original data on occupational injuries, which are generated in the business system, are also used by processes and users in government and public subsystem of occupational safety system for drafting statistical and other reports and information on occupational injuries on the public and national level of occupational information management. The problem of communicating data through prescribed written documents from the business system level towards macro levels of public and national system, as well as information backlinks, is specially emphasized.

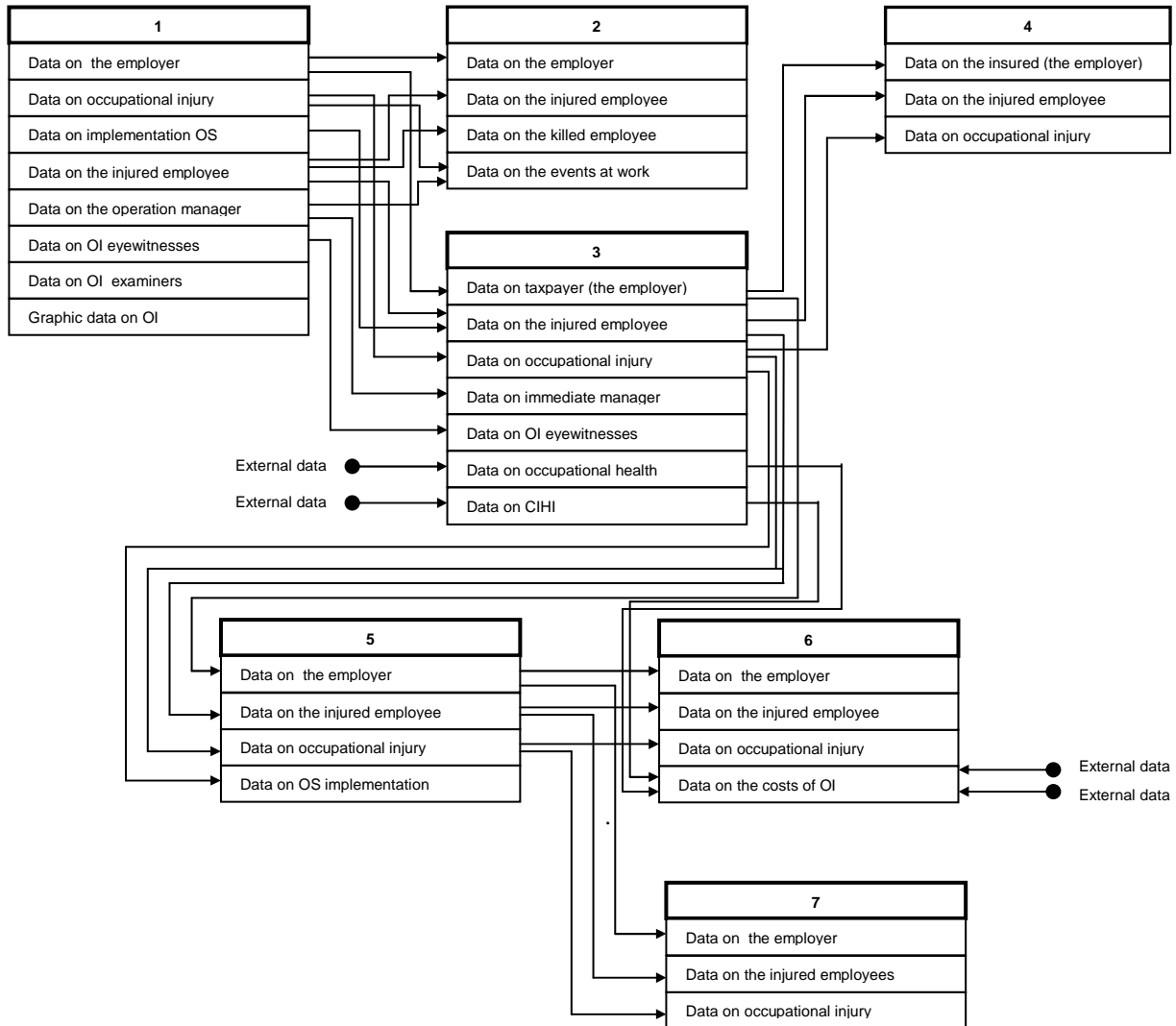


Figure 1 Data model in the existing system of occupational injury information management

Symbols:

- 1 - The record on examination of occupational injury
 - 2 - The notification of an event at work that caused death, serious injury and injury of two or more workers, regardless of severity of injury
 - 3 - The registration of occupational injury
 - 4 - The registration insured event due to occupational injury
 - 5 - The record board employees who are injured at work and on workers who are ill at work
 - 6 - The calculation of costs (prices) of occupational injury
 - 7 - The annual report on occupational injuries and occupational diseases of workers at work
- OS - Occupational safety
 OI - Occupational injury
 CIHI - The Croatian institute for Health Insurance

Establishing strategic guidelines for improving occupational injury information system and knowledge management

The following strategic guidelines for improving occupational injury information system and knowledge management have been determined based on the analysis of the theoretical basis and analysis of the existing occupational injury information management system.

- 1) Integrity of occupational injury information system and knowledge management.
- 2) Consistency of occupational injury information system and knowledge management.
- 3) Reengineering of the existing information processes of reporting and analyzing occupational injuries.
- 4) Use of modern information and communication technology (ICT) in occupational injury information system and knowledge management.
- 5) Contribution of occupational injury information system and knowledge management to occupational safety enhancement.

Reengineering of information processes for the improvement of occupational injury information system and knowledge management

Reengineering of the existing information processes of reporting and analyzing occupational injuries is the basic precondition of the successful computerization and thereby the improvement of occupational injury information system and knowledge management, as well as the overall occupational safety system.

As determined by the current situation analysis, reengineering of information processes is possible and necessary, especially in the current process of document management in the existing occupational injury information management system. It will simplify administrative procedures and the number of separate documents, which is especially important for process computerization, and create conditions for data integrity and consistency and avoid redundancy of key data on occupational injuries.

Figure 2 shows the result of re-engineering. The beginning of such new process is an individual case of occupational injury of the employee in the business system that causes and generates data on occupational injury. During the first and crucial step of the procedure, occupational safety professionals in the business system collect all necessary and relevant data on occupational injury, which later can be used in other steps of the procedure. These data, which can also be in multimedia formats (digital photos, video, digital recordings of interviews, simulations, etc.), are stored in a computer database using ICT.

In the second step of the procedure, an occupational injury is officially reported to the relevant state institutions. Occupational safety professionals use data from the database from the first step, which are also

available to other participants in the process of occupational injury reporting. Occupational injury notification is submitted through the Internet, as well as all other necessary data. The course of the occupational injury notification process can be monitored through the Internet as well as its final status.

The data on individual occupational injuries in business systems are stored in a single computer database of all occupational injuries in Croatia, which is kept by a competent and neutral government body (Croatian Institute for Health Protection and Safety at Work). The public portion of the data on occupational injuries is immediately available to all interested parties from business, public and national occupational safety system for the analysis and statistical reports, which makes the third step of the procedure.

Data and information on occupational injuries gathered and processed this way are a professional foundation for the improvement of occupational safety by creating a repository of new occupational safety knowledge and measures, which includes all interested parties with the help of the Internet. That is also the last, fourth step in the reengineering of information processes of reporting and analyzing occupational injuries.

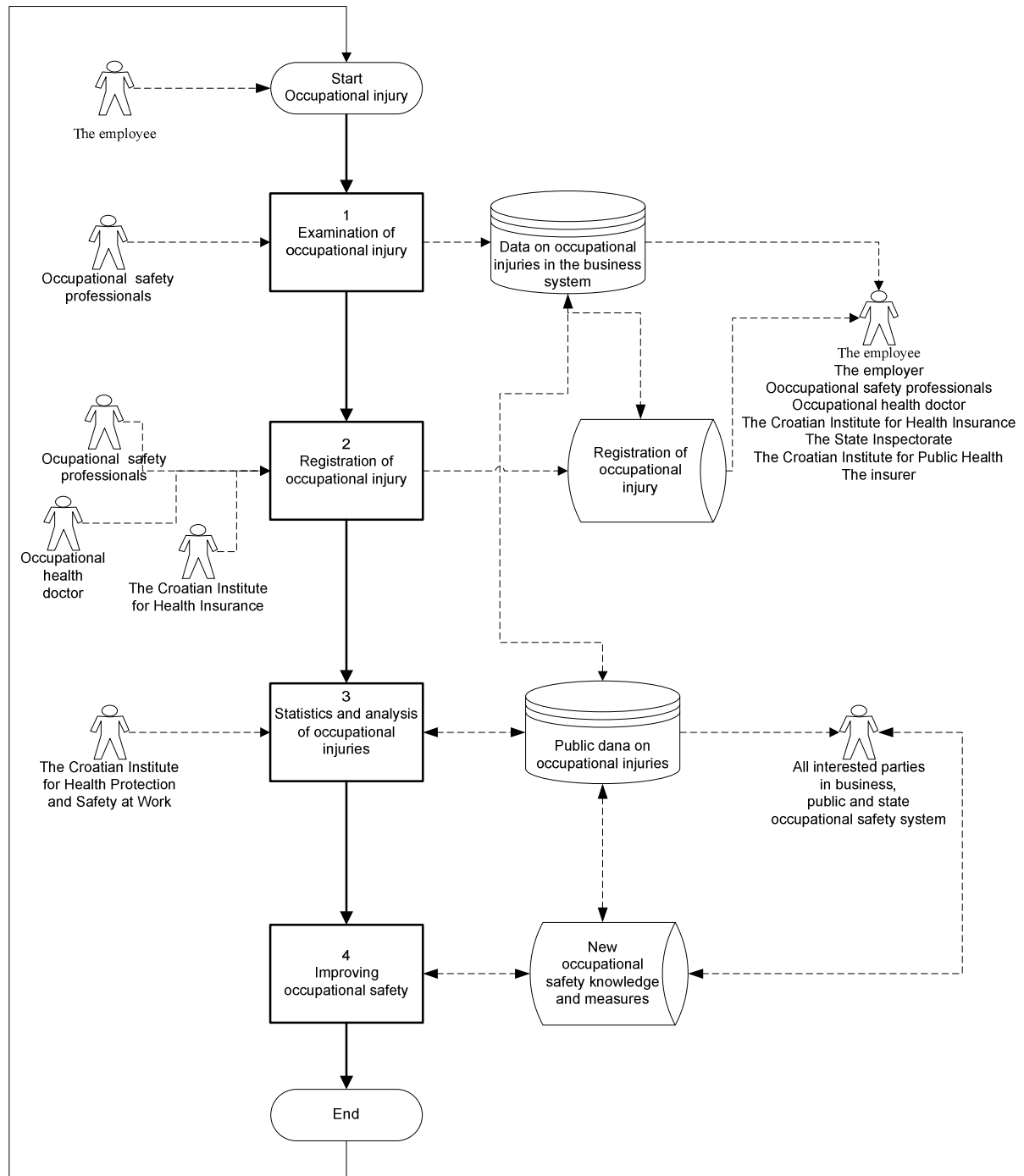


Figure 2 Reengineering of information processes for the improvement of occupational injury information system and knowledge management

Model of occupational injury information system and knowledge management

Following the completion of the information process reengineering, it is possible to establish a model of occupational injury information system and knowledge management, which is based on modern information and communication technology (Figure 3).

The information system has Network Computing Architecture, uses public Internet infrastructure, and essentially consists of a central computer database and web service and all licensed and authorized users from the business, national and public occupational safety system, as well as other interested parties and professional and general public.

A professional and independent state institution (Croatian Institute for Health Protection and Safety at Work) is responsible for the management of the single and central occupational injury database and web service, and thus the entire information system. Such model of information system management, based on modern information and communication technology and Internet infrastructure can be characterized as the current trend of the information system "in the Cloud."

The complete computerization of processes and systems for reporting, recognition and analysis of occupational injury data is established by this model.

An authorized occupational safety professionals enters key data on occupational injury in the information system at the scene of injury in the business system. He may also use certain data from the existing business information system. Other participants from the business system involved in the process, primarily the employer and the injured employee, have the ability to access and view the data on occupational injury and reporting procedure.

A physician, that is, an occupational medicine has the ability to enter certain technical data on occupational injury, of which each has a unique identification number. The competent authority (Croatian Institute for Health Insurance) has the ability to modify the official data during the process of occupational injury recognition. Other participants (State inspectorate - occupational health and safety inspection, Croatian National Institute of Public Health and insurers) may also view the data and add their own specific data, once an occupational injury is officially recognized and verified.

Information on occupational injuries, primarily statistical analysis and data and new formalized knowledge and rules are available to all other interested parties and the general public through public access to the information system.

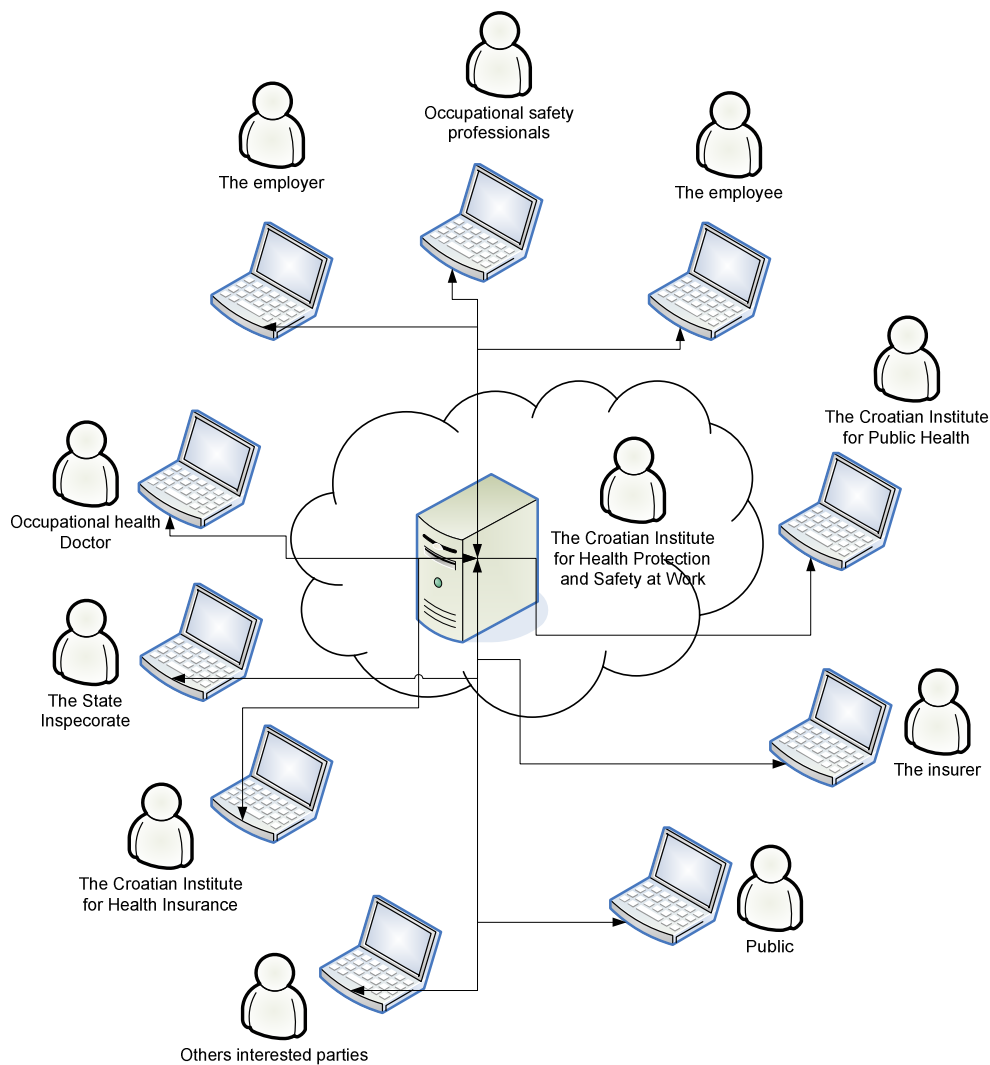


Figure 3 Model of occupational injury information system and knowledge management

CONCLUSION

Theoretically and practically applicable model of occupational injury information system and knowledge management has been established on the basis of the re-engineering of information processes of occupational injury reporting and analysis and the possibility of application of modern information and communication technology, especially the Internet. The integrity of the model is verified through simple inclusion of all elements, participants and other stakeholders as well as the general public in the system. The consistency of the model is confirmed by the uniqueness of occupational injury information system and knowledge management.

Any authorized, professional and independent state body can manage this model. That way, all relevant occupational injury data entry can be implemented and monitored, only once at the site of the injury in the business system, as well as the subsequent procedures in the national and public occupational safety system. Only certain professional and authorized persons may enter these data. Such model of occupational injury information system and knowledge management can significantly contribute to the improvement of the overall occupational safety system, while it provides quality and timely information and new knowledge about occupational injuries that are crucial for decision support and effective knowledge management in the occupational safety system.

The aim of the modern organization is to observe all business processes as the beginning of knowledge. This includes the creation of knowledge, its expansion, improvement and application throughout the organization. Modern organizations are seeking ways to create additional value through the discovery and application of knowledge. Organizations and their managers should strive to create more explicit knowledge, which is collective by nature and cannot disappear when a person leaves an organization. Explicit knowledge contained in the bank of data, information and knowledge of an organization amounts between 10-20 %, and this part can be doubled by applying the concept of knowledge management [21].

As a recommendation for further, it is suggested to conduct a large research on the use of ICT in occupational safety system, as well as research and development of detailed models of occupational injury and safety information system and knowledge management in Croatia, and their connection and compatibility with similar systems at the international level.

MODEL UPRAVLJANJA INFORMACIONIM SISTEMOM I ZNANJEM O POVREDAMA NA RADU

Rezime: Cilj istraživanja je uspostavljanje celovitog i konzistentnog modela upravljanja informacionim sistemom i znanjem o povredama na radu kao značajne pretpostavke unapređenja sistema bezbednosti i zdravlja na radu. Teorijski i praktično primenljiv model upravljanja znanjem o povredama na radu uspostavljen je na temelju reinženjeringa informacionih procesa prijave i analize povreda na radu te mogućnosti primene savremene informaciono-komunikacione tehnologije, posebno Interneta. Celovitost modela potvrđuje se u jednostavnoj mogućnosti uključivanja u sistem svih elemenata, učesnika i zainteresiranih strana, pa i najšire javnosti. Konzistentnost modela potvrđuje se u jedinstvenosti upravljanja informacionim sistemom i znanjem o povredama na radu.

Ključne reči: informacioni sistem, model, povreda na radu, upravljanje znanjem, zaštita na radu.

REFERENCES

- [1] Pauše, Ž.: Uvod u teoriju informacije, Školska knjiga, Zagreb, 2003.
- [2] Krakar, Z.: Upravljanje informatizacijom, Sveučilište u Zagrebu, Fakultet organizacije i informatike, Varaždin, 2003.
- [3] Sinković, V.: Informacija, simbolika, semantika, Školska knjiga, Zagreb, 1997.
- [4] James, P.N.: The IS Executive and Strategic Planning, in: C. V. Brown, H. Topi (ed.) et al.: IS Management Handbook, 7th Edition, Auerbach, Boca Raton, London, New York, Washington, 2000.
- [5] Casmore, C., Lyall, R.: Business Information: Systems and Strategies, Prentice Hall, New York, London, 1991.
- [6] Laudon, K.C. Laudon, J.P.: Management Information Systems, Managing the Digital Firm, Pearson Prentice Hall, New Jersey, 2004.
- [7] Hoving, R.: Knowledge Management - Coming Up the Learning Curve, in: C. V. Brown, H. Topi (ed.) et al.: IS Management Handbook, 7th Edition, Auerbach, Boca Raton, London, New York, Washington, 2000.
- [8] Santosus, M., Surmacz, J.: ABC knowledge management www.cio.com/research/knowledge/edit/kmabcs.html
- [9] Shockley, W.: Planning to Knowledge Management, USA, Quality Progress, 2000.
- [10] Kacian, N.: Osnove sigurnosti, Zagreb, IPROZ., 2000.
- [11] Petersen, D.: Measurement of Safety Performance, Des Plaines, American society of safety engineers, 2005.
- [12] Petersen, D.: Techniques of Safety Management: A system approach, Des Plaines, American society of safety engineers, 2003.
- [13] Petersen, D.: Safety by Objectives, New York, John Wiley and Sons, 1996.
- [14] Petersen, D.: Analyzing Safety System Effectiveness, New York, John Wiley and Sons, 1996.

- [15] Hopkins, A.: Thinking about process safety indicators, *Safety Science*, 47, 2009, pp 460-465.
- [16] Janačković, G, Savić, S., Stanković, M.: Safety Performance Indicators in Organizational Safety Management Systems, in: *Proceedings of the 2nd International Conference Life Cycle Engineering and Management ICDQM-2011*, Belgrade, pp 131-139
- [17] Milošević, M., Furlan, M.: Nužna informatizacija prijava ozljeda na radu, *Sigurnost*, 53, 1, 2011, Zagreb, str. 89
- [18] Pavlič, M., Likara, B., Pavlič, A., Markič, M.: Managing occupational accidents records in Slovenia from 1948- 2008 , *Safety Science* 49, 2011, pp.834-842.
- [19] Jacinto, C., Aspinwall, E. A survey on occupational accidents' reporting and registration systems in the European Union. *Safety Science* 42, 2004. pp.933-960.
- [20] Macedo, A.C., Silva, I.L.: Analysis of occupational accidents in Portugal between 1992-2001. *Safety Science* 43, 2005. pp 269-286.
- [21] Sydanmaanlakka, P.: *An Intelligent Organization: Performance, Competence and Knowledge Management*, Capstone, Oksford, 2002.

BIOGRAPHIES

Josip Taradi, M.Sc.

He lives and works in Croatia. He holds a BA in Safety engineering, MA in Safety (University College of Safety, Zagreb) and MA in Social Sciences in the field of Information Science and Management (Faculty of Organization and Informatics in Varaždin, University of Zagreb). He is a Senior Lecturer at the University College of Applied Sciences in Safety in Zagreb and Split. He is the Head of an Integrated Quality System in the public utility company Međimurske vode d.o.o. in Čakovec. He is an author and co-author of two monographs, and 50 professional and 35 scientific papers. He is the Head of three research projects. He is the founder and first president of the Croatian Society of Safety Engineers. He is the Secretary of the Conference "Management and Safety" in Čakovec. Research interests: safety, quality, management.

