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The Architecture of the Intelligent Case-Based Reasoning Recommender System (CBR RS) Recommending Preventive/Corrective Procedures in the Occupational Health and Safety Management System in an Enterprise

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Abstract

The paper presents the original architecture of the system recommending preventive/corrective procedures in the occupational health and safety management system in an enterprise: ComplianceOHS-CBR. The system consists of four modules: Module A — an ontology of the workplace OHS profile, Module B — an ontology of preventive/corrective procedure indexation OPCPI, Module C — a recording system of the monitoring process of non-compliance with the requirements of OHS, Module D — a recommending engine consistent with the CBR methodology. The essence of the approach presented in this paper is integration of the monitoring system of the analysis process of non-compliance with the requirements of OHS at the workplace (the ADONIS system was used) with the case-based reasoning process (CBR). The integration platform consists of two ontologies: an ontology of profile compliance with the workplace OHS requirements (OP-OHS) and an ontology of preventive/corrective procedure indexation (OPCPI). Both of the ontologies are presented in the Protege 5 OWL editor. Inference engines are alternatively, according to the CBR methodology, myCBR and jCOLLIBRI.

Keywords: recomme nder system, Case-Based Reasoning (CBR), OHS, monitoring process of non-compliance OHS, ontology of profile compliance OHS, OWL, Protege, ADONIS, myCBR, jCOLLIBRI

JEL: C6, C88, J28, M54

Introduction

One of the intensively developed directions in the area of decision support systems (DSS) is the design of recommender systems (RS) (Bobadilla et al. 2013). The task of a recommender systems is to fit a specific recommendation (e.g., a product sold in the online store) to the client requirements or expectations. E-commerce became the first area of application. Recommender systems are now designed in other areas: in the selection of learning content in online courses (e-learning recommender system), in the selection of government services (e-government recommender system), in the selection of business services (e-business recommender systems), in the selection of services in tourism (e-tourism recommender systems), in the selection of scientific books and papers (e-library recommender systems), in the selection of services in the Internet (e-resource service recommender systems), and in recommendations for consumer groups (e-group activity recommender systems) (Lu et al. 2015). Modern recommender systems go beyond the framework of classic systems recommending products in online stores (i.e., systems used in e-commerce).

Significant modules incorporated into the architecture of recommender systems are: a module of knowledge extraction, a module of domain knowledge representation, and a module of profiling recommendations. These modules require the formulation of, respectively, a domain ontology, a task ontology, and a recommendation profile ontology. Recommendations, in the presented system, are formulated in the form of processes outlined using the BPMN notation.[1] The indexation method of procedures recorded in the BPMN notation on the basis of an ontology is required. The next problem is to design a task ontology that will encompass an analysis of the situation of safety in individual workplaces in accordance with the requirements laid down in OHS regulations. A domain ontology should correspond to terminology included in: the PN-N-18001 standard (Occupational Health and Safety Management Systems — Requirements), the PN-N-18002 standard (Occupational Health and Safety Management Systems — General guidelines for risk assessment), the PN-N-18004 standard (Occupational Health and Safety Management Systems — Guidelines), the PN-N-18011 standard (Occupational Health and Safety Management Systems — Guidelines for audits), the PN-EN ISO 12100 standard (Machine safety — basic notions, general designing principles, risk assessment and risk reduction).

An example of the ontology oriented system, combining analysis of the situation of safety and the recommendation of specific procedures, is the RAMIRES (Risk-Adaptive Management in Resilient Environments with Security) system (Teimourikia and Fugini 2017). In this system, the MAPE-K (Monitor-Analyze-Plan-Execute and Knowledge) method, based on the ISO31000:2009 standard, is used for risk assessment of situations in the environment managed by IoT (Internet of Things). The RAMIRES system generates procedures (strategies) of safety rules on the basis of decision rules.

Lu, Li and Xiao (2013) presented the classic CBR system for analysis of the risk of railway accidents. A description of the cases is presented using defined terms in the ontology of the circumstances of the accident. Virkki-Hatakka and Reniers (2009) developed the Nextcase/safety platform as a tool aiding preventive actions based on reasoning by analogy to the specific cases that define accidents in the shipbuilding industry. Amailef and Lu (2013) developed the OS-CBR system for emergency analysis in local administrative units. To describe the cases, the domain ontology for characterizing potential threats was defined.

This paper presents an architecture of the system recommending preventive/corrective procedures in the OHS system of an enterprise. This architecture covers integration of the monitoring system of non-compliance with the requirements of OHS at specific workplaces and the recommender system (RS) based on the Case Based Reasoning (CBR) (Aamodt and Plaza 1994) methodology (standard procedures). The essence of recommendation is to determine relationships between non-compliance indicators with the requirements of OHS, and the preventive/corrective procedure. The key role in the description of cases is played by ontology. The ontology covers the taxonomy of concepts in the OHS domain oriented towards monitoring processes of non-compliance with the requirements, as well as the preventive/corrective procedures. The ontology presented in this paper consists of two parts: the ontology of the OHS profile of the workplace (OP-OHS) and the ontology of preventive/corrective procedure indexation (OPCPI).

1 The architecture of the ComplianceOHS-CBR system

The original architecture of the ComplianceOHS-CBR system consists of four modules:

- module A: the ontology of the workplace OHS profile,
- module B: the ontology of preventive/corrective procedure indexation OPCPI,
- module C: the recording system of the monitoring process of non-compliance with the OHS requirements, and
- module D: the recommending engine consistent with the CBR methodology.

The relationships among modules are presented in figure 1. A case is described by means of three elements: a set of indicators characterizing non-compliance with the OHS requirements at the respective workplace, a set of communication transactions characterizing preventive/corrective procedures in the OHS system of an enterprise as well as registration data of preventive/corrective procedures

1. See: About the Business Process Model And Notation Specification Version 2.0. [@:] http://www.omg.org/spec/BPMN/2.0/.

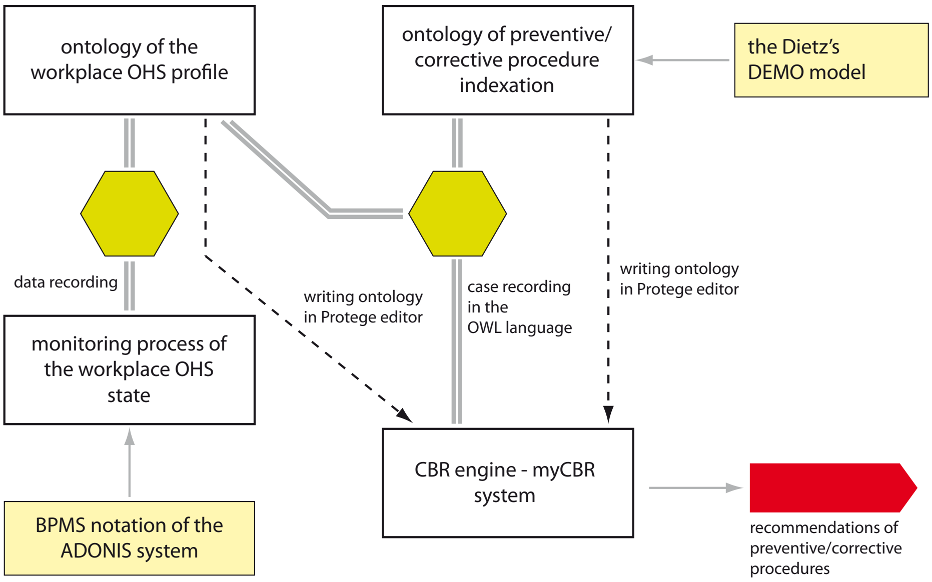

Fig. 1. The architecture of the ComplianceOHS-CBR system. The BPMN conversation diagram

which are outlined using the BPMN notation. The non-compliance state with the requirements is identified in the monitoring process by means of the ADONIS system. The particular models in the ADONIS system are defined using concepts included in the OP-OHS ontology of the workplace OHS profile. In this ontology, a key role is played by the respective functions controlling non-compliance with the requirements: the function of competence non-compliance, the function of non-compliance of use, the function of non-compliance of behaviors, the function of signalization non-compliance, the function of information non-compliance, and the function of OHS policy non-compliance. Each function is based on an appropriate checklist, on the basis of which data are calculated for the OHS state indicators The ontology OPCPI of preventive/corrective procedure indexation is used to determine the scope of the relevant procedures with the aid of the transaction list identified using the DEMO model developed by Dietz. In the next chapters, particular elements of an architecture of the ComplianceOHS-CBR system are presented.

2 The Ontology OP-OHS of the workplace OHS profile

The main area of the occupational health and safety management system, according to the PN-N-18004:2001 standard,[2] is "a control and preventive/corrective actions." In this area, the standard distinguishes three processes: the process of identification of non-compliance and decision making on the application of preventive/corrective actions, the monitoring process of occupational health and safety, and the process for carrying out internal audits of the management system. All three processes result from a detailed analysis of non-compliance with the specific requirements. The requirements are specified in the OHS regulations for specific workplaces.

In modern recording systems of the ERP class, modules for recording non-compliance are included. An example of such a module is the NND Claims module: supervision of claims, non-compliance and threats (see: the NND INTEGRUM system by Tkomp Bydgoszcz). The module allows us to describe the corrective, correlation and preventive actions taken together with the assessment of their correctness and effectiveness. This system has been implemented at PGE Dolna Odra Power Stations. Records of non-compliance in this system contain the following fields: non-compliance id, non-compliance specification, the way to remove non-compliance, non-compliance status (removed, active), and the reasons for non-compliance (employees, technologies, equipment, materials).

2. See: Polska Norma PN-N-18004. Systemy zarządzania bezpieczeństwem i higiena pracy. Wymagania. Polski Komitet Normalizacyjny 2001.

Ly et al. (2015) presented the framework of functionality in monitoring compliance in business processes that are recorded in the ERP, CRM, and WMS systems. In the CMF (Compliance Monitoring Functionality) arrangement, there are 10 functionalities in three groups of requirements:

- the group of modeling requirements:
  CMF 1: Constraints referring to time
  CMF 2: Constraints referring to data
  CMF 3: Constraints referring to resources
- the group of execution requirements:
  CMF 4: Supporting non-atomic activities
  CMF 5: Supporting activity life cycles
  CMF 6: Supporting multiple instances constraints
- the group of user requirements:
  CMF 7: Ability to reactively detect and management
  CMF 8: Ability to pro-actively detect and manage violations
  CMF 9: Ability to explain the root cause of a violation
  CMF 10: Ability to quantify the degree of compliance

In the CMF model, the typical compliance rules have been determined.

Saracino et al. (2015) presented the M.I.M.O.SA. (Methodology for the Implementation and Monitoring of Occupational Safety) methodology for assessment of occupational health and safety in an enterprise. The methodology consists of a hierarchical structure of the following items:

- level I: The key elements of the OHS system
- level II: Themes of occupational safety
- level III: 1. Checklists with questions related to planning
  2. Checklists with questions related to acting
- level IV: Key Performance Indicators (KPIs)

The M.I.M.O.SA. methodology concerns the analysis of the whole enterprise. The global indicator of OHS for the enterprise is defined.

In this paper, the concept of the non-compliance analysis for each workplace is presented, so that the value of the OHS state indicators mean compliance/non-compliance with the relevant requirements, which are placed in the checklists. The scheme of concepts is presented in the original ontology of the OSH profile of the workplace. The basic concept in the OP-OHS ontology is a function of non-compliance.

Definition 1

- **The function of non-compliance Fi**: LKFi → {KPI, OPT, FUN, STAT, PAT, CLAS, REF}
  The function of non-compliance Fi assigns, to each checklist of the particular workplace, a set of indicators of the OHS state of this workplace.
- **Fi — functions of non-compliance**:
  - **F1: the function of competence non-compliance**, determined on the basis of a checklist related to legal and normative requirements of human resources
  - **F2: the function of non-compliance of use**, determined on the basis of a checklist related to requirements for machines, devices and means of transport according to the relevant standards — e.g., PN-EN ISO 12100 Safety of machinery — General principles for design — risk assessment and risk reduction[3]
  - **F3: the function of non-compliance of behaviors**, determined on the basis of a checklist related to requirements in observations of behavior of employees in a given workplace; the checklist corresponds to the observation card used in audits of behavior, for example, in the STOP system made by Du Pont[4]

3. See: PN-EN ISO 12100. Bezpieczeństwo maszyn. Ogólne zasady projektowania. Ocena ryzyka i zmniejszanie ryzyka. PKN Warszawa 2011.
4. See: http://www.dupont.com/.

- **F4: the function of signalization of non-compliance**, determined on the basis of a checklist related to requirements specifying the efficiency of the signaling, such as ventilation systems, smoke alarms, fire protection devices, etc.
- **F5: the function of information non-compliance**, determined on the basis of a checklist related to requirements defining the distinguishability of the messages (verbal, acoustic, optical, etc.)
- **F6: the function of OHS policy non-compliance**, determined on the basis of a checklist related to requirements of the established OHS policy at the analyzed workplace; the requirements identified in the policy are determined using the Balanced Scorecard (BSC) method (Kaplan and Norton 1996)

- **LKFi — the checklist** including a set of questions or statements related to requirements formulated in: OHS regulations for a given workplace, standards, observation cards, documentations of machinery and equipment, balanced scorecards, etc.
- **KPI — the key performance indicator**, a synthetic indicator for satisfying the priority requirements of a given workplace, related to the demands of strategic objectives under the OHS policy
- **OPT — the optimization indicator**, an indicator covering extrema (maximum, minimum) of the quality function, for example, the minimum number of injuries as a function of time of a use of the equipment (e.g., a forklift).
- **FUN — the function indicator**, an indicator for the function monotonicity (increasing, decreasing), for example, a 10% decrease in injuries at a given workplace, a 5% increase of the probability of injuries at the workplace
- **STAT — the statistical indicator**, an indicator of exceedance of statistical parameters, for example, the mean number of alarm signals per day
- **PAT — the pattern indicator**, an indicator concerning discrepancies in relation to a specific pattern, for example, deviation from the linear trend of the growth in the number of control signals as a function of the complexity of the technological operations
- **CLAS — the classification indicator**, an indicator determining the behavior states (normal state, abnormal state, transient state)
- **REF — the reference indicator**, an indicator concerning discrepancies in relation to the reference values shown in the relevant standards (e.g., reference values of noise level at the workplace).

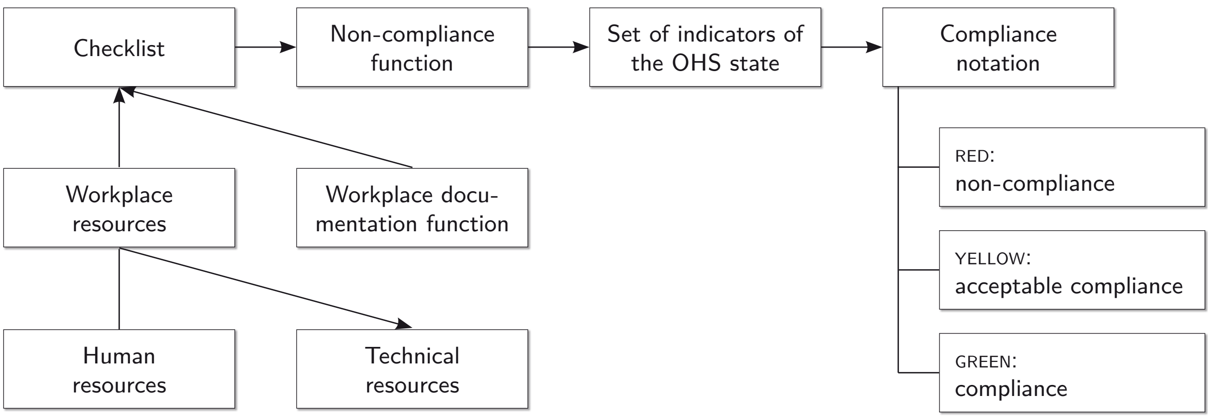

Fig. 2. The general scheme of concepts in the OP-OHS ontology

In figure 3, a class diagram of the OP-OHS ontology of the workplace OHS profile is shown using OntoGraf. In the list of classes of OP-OHS ontology, there have been included categories of resources which are available at a given workplace and documentation that corresponds to the individual functions from F1 to F6. Resources — human resources and technical resources which are available at a given workplace; human resources cover the following types of employees: worker performing technological operations, machine operator, operator of a transport means, auxiliary worker; technical

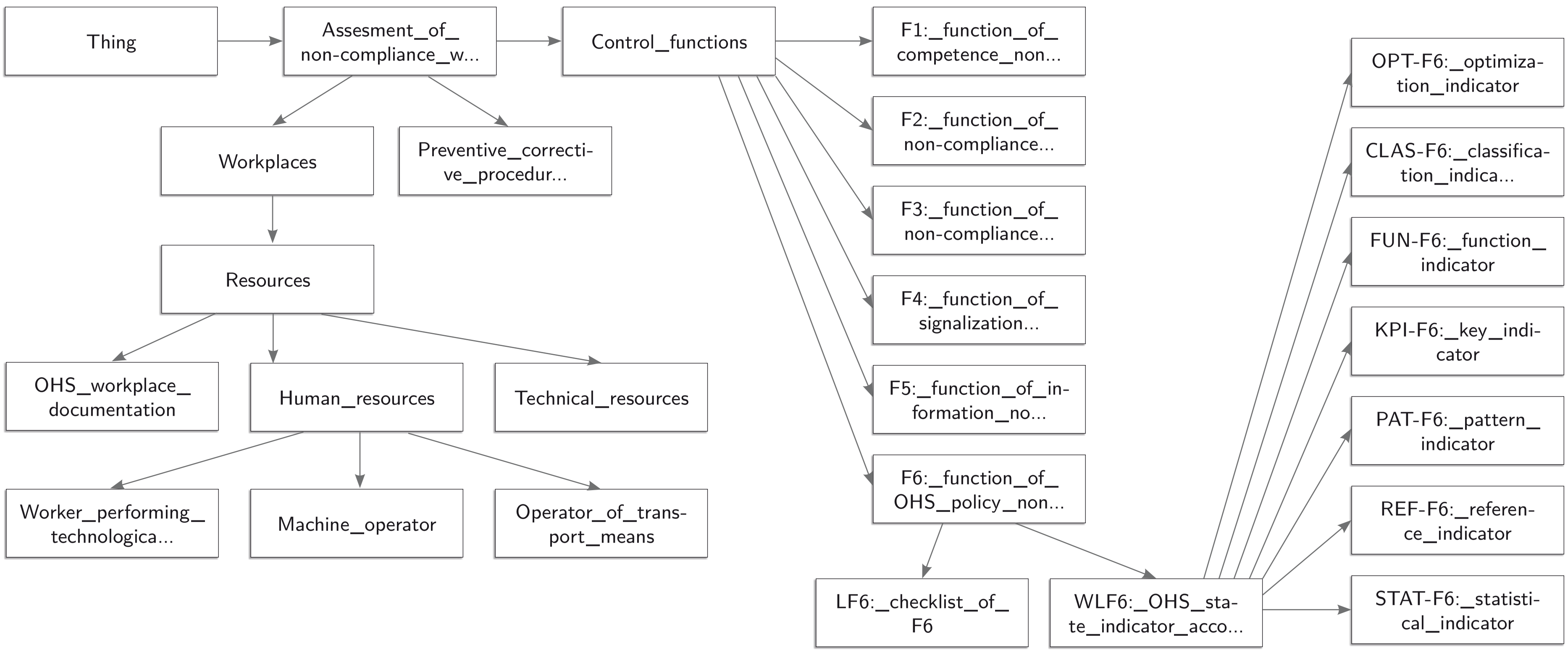

Fig. 3. A class diagram of the OP-OHS ontology of the workplace OHS created using OntoGraf

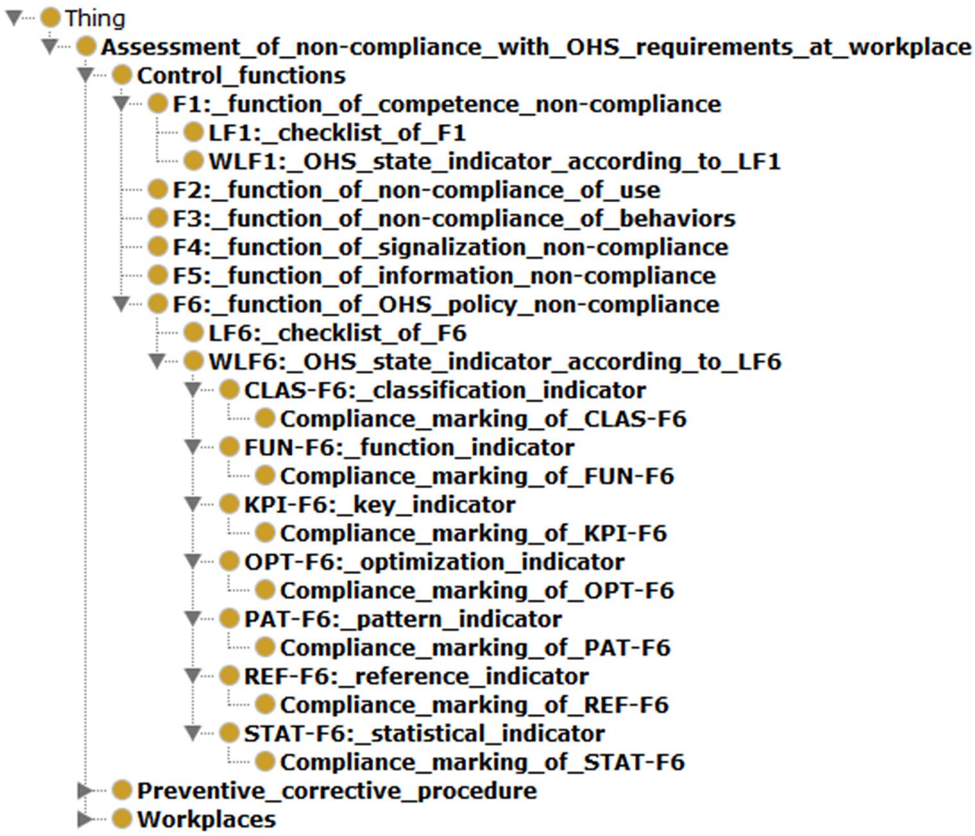

Fig. 4. A class hierarchy the OP-OHS ontology created in Protege 5 (control functions)

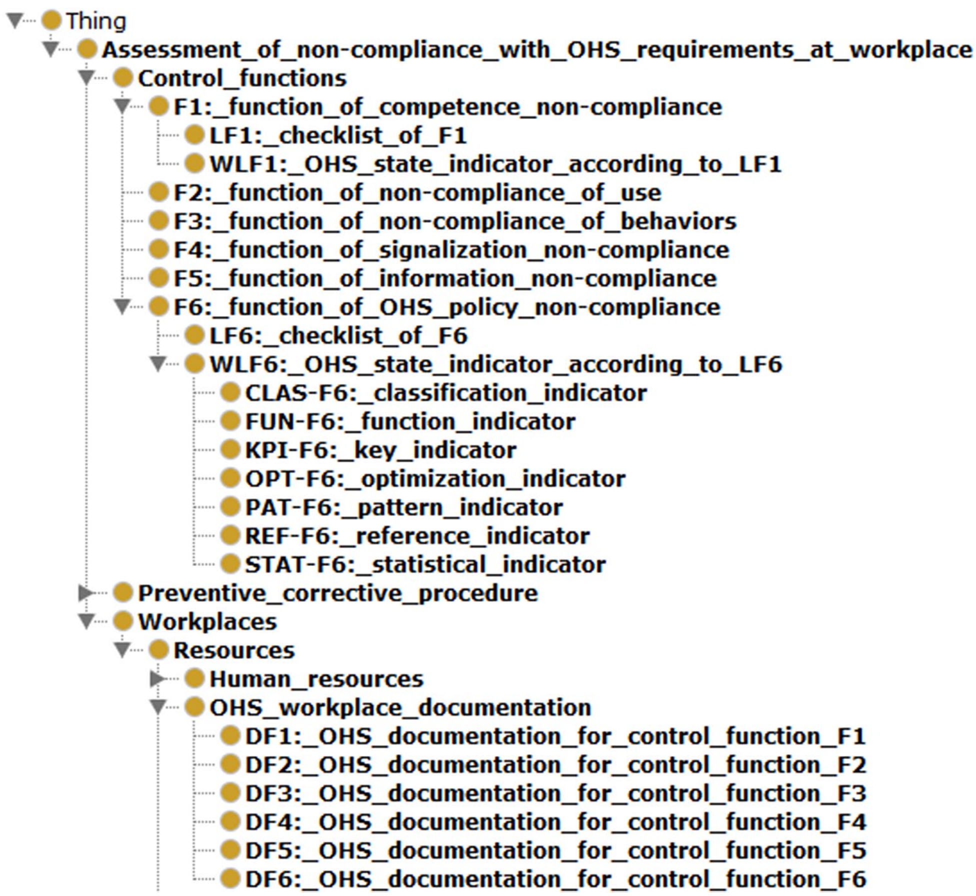

Fig. 5. A class hierarchy the OP-OHS ontology created in Protege 5 (indicators and documentation)

resources cover: machinery, safety barriers, signaling installations, installations against threats, and personal protective equipment. Documentation of the workplace — documentation required at the workplace, on the basis of which checklists allocated to appropriate functions F1 – F6 are formulated. Figures 4 and 5 present a class hierarchy the OP-OHS ontology created in Protege 5.

3 The Ontology of Preventive/Corrective Procedure Indexation (OPCPI)

Enterprises own libraries of standard processes, which are executed depending on specific decision situations. It concerns, especially, enterprises which have implemented quality management systems in accordance with ISO 9001:2010 standards. An integral part of the Quality Manual is a process map with distinguished procedures (sub-processes). Preventive/corrective actions are entered into particular procedures of the quality management system. The procedures can be described in a form of activity lists or activity flow diagrams or block diagrams. Due to the possibility of inclusion in the processes, not only of actions but also a wide variety of events regarding time dependencies, rules, communication events, etc., a convenient way of process notation is BPMN([5]). Unification of preventive/corrective procedures written in the BPMN notation can be implemented using the DEMO (Design and Engineering Methodology for Organization) model of the enterprise ontology designed by Dietz (2006). The DEMO model includes four layers of communication process modelling:

1. Construction Model (CM) — covering specification of transactions between actors involved in the execution of a business process.
2. Process Model (PM) — covering specification of a communication process in the BPMN notation.
3. Action Model (AM) — covering a list of business rules implemented by the actors of the business process.
4. State Model (SM) — covering specification of classes of objects and types of facts.

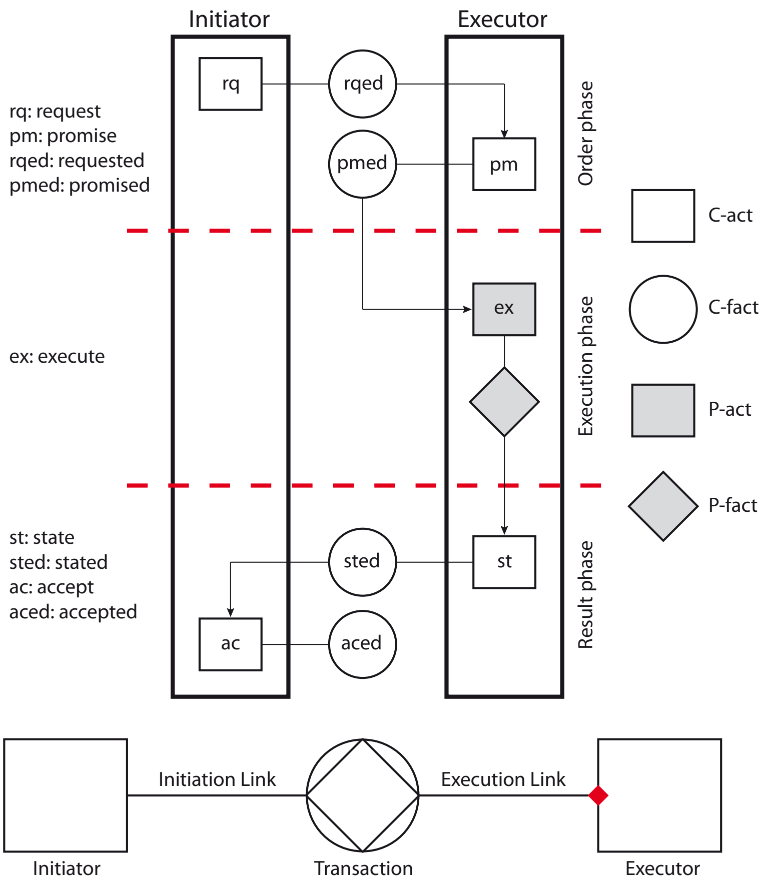

Fig. 6. A process pattern encompassed by the transaction in the DEMO notation according to Dietz

5. See: Business Process Model & Notation™ (BPMN™). [@:] http://www.omg.org/bpmn/.

In the DEMO model, two kinds of acts are determined: a communication act (action), P-act, and a coordination act, C-act, representing liabilities between entities. The process consists of facts that are the result of relevant acts. The transaction involves three phases: the phase of a request for proposal, the phase of realization, and the phase of the results. The transaction covers a fragment of the process consisting of standard communication actions: rq: request, pm: promise, ex: execution, st: statement, ac: acceptance, and events arising from the implementation of the appropriate actions, rqed: requested, pmed: promised, sted: stated, aced: accepted. The DEMO model is used in the simulation of surgical operations (Yahia et al. 2017). A scheme of standard transactions which are included in the complex process of the surgical operation. Rao and Nayak (2017) presented a set of transactions included in the process of extraction of the knowledge hidden in the process of creating cases in the CBR methodology. Dietz presented a number of standard transactions in the organizational processes.[6] Seck and Barjis (2015) applied the DEMO model to simulation of the process of patient diagnosis.

In this paper, the DEMO model is used for indexation of standard preventive/corrective procedures in the OHS system of an enterprise. Figure 7 shows the transaction diagram for the procedure of occupational medical check-ups. The procedure consists of two transactions:

- T01: the delegation of the employee to perform periodic occupational medical check-ups, and
- T02: execution of occupational medical check-ups in the occupational medicine clinic.

The result of transaction T01 is a referral to the occupational medicine clinic, provided by the law, agreed upon with the employee. The result of transaction T02 is a medical certificate of health for the employee. Transactions cover the process realized by two actors:

- T01: (A1: human resource department, A2: employee), and
- T02: (A2: employee, occupational medicine clinic).

Figure 8 presents an example of the process covered by transaction T01 in the BPMN notation.

The ontology of preventive/corrective procedure indexation consists of the following concepts:

- Preventive/corrective procedure — a process written in the BPMN notation in two diagrams: a conversation diagram, in which standard transactions are distinguished and a diagram of standard patterns of processes corresponding to transactions included in a conversation diagram.
- Transaction — a standard scheme of communication between a pair of actors: an initializing actor and an actor performing tasks.
- Initiator — human resources of a workplace, human resources of organizational units included in the OHS system, organizational units of an enterprise which participate in the initiation and conduct of the communication transaction.
- Executor — human resources of a workplace, human resources of organizational units included in the OHS system, organizational units of an enterprise which participate in performing specific tasks determined by the procedure.
- Transaction result — a document, a technical or human resource covered by preventive/corrective actions in a state after realization of these actions.
- Human resource state — a state of a human resource after execution of a certain transaction in the preventive/corrective procedure. The following states are distinguished: training, passing the exam, getting the certificate, reprimanding, rebuking, dismissal.
- Technical resource state — a state of a technical resource after execution of a certain transaction in the preventive/corrective procedure. The following states are distinguished: resource change, resource repair, resource exchange, and resource replenishment.
- Document state — a state of a document after execution of a certain transaction in the preventive/corrective procedure. The following states are distinguished: update, entering a new document, and entering a new version of the document.

In Figure 10, the diagram of classes of the ontology OPCPI of preventive/corrective procedure indexation is shown.

6. See: The PSI theory — Understanding Human Collaboration. Technical Report number TEE-03 v4.3, October 2017, doi: 10.13140/RG.2.2.12739.91680, [@:] https://www.researchgate.net/publication/320298882_The_PSI_theory_-_understanding_human_collaboration.

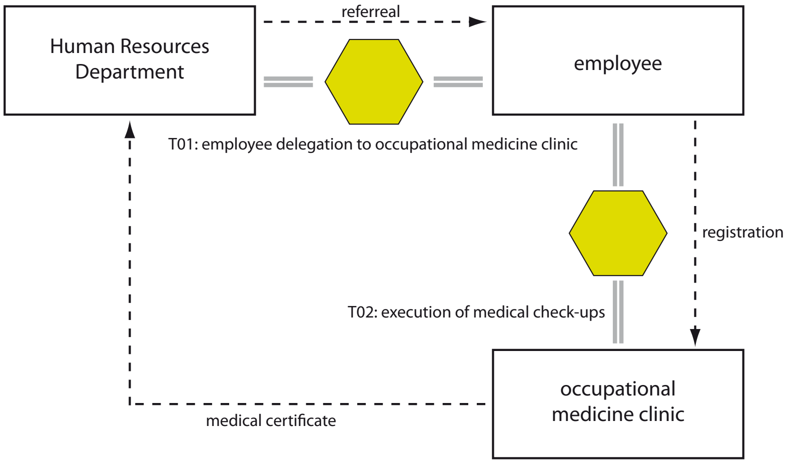

Fig. 7. The transaction diagram for the procedure of occupational medical check-ups written in the BPMN notation (conversation diagram)

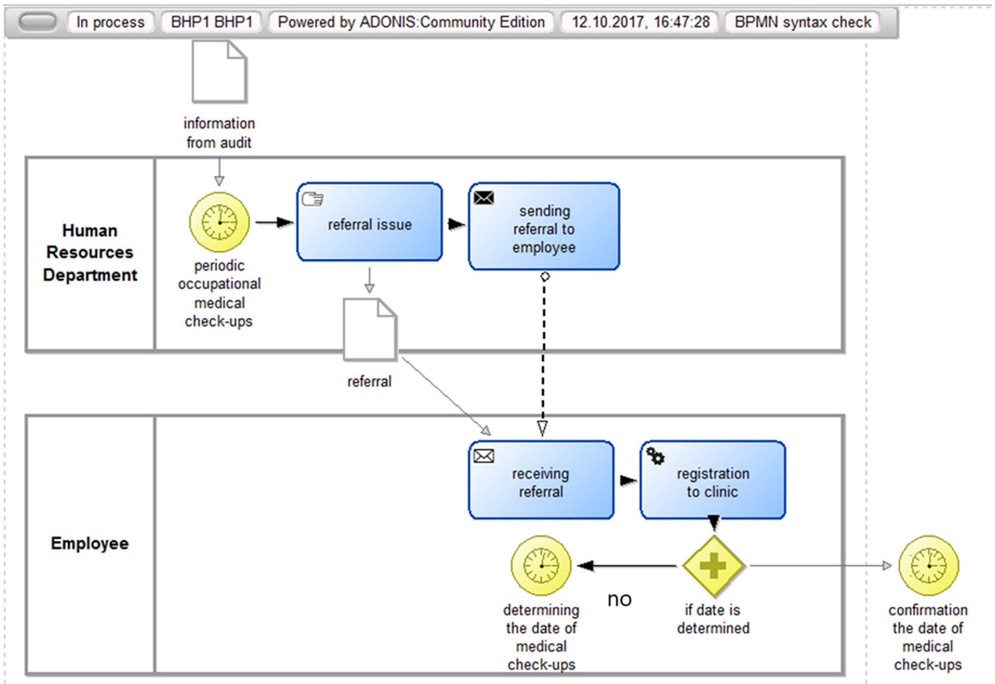

Fig. 8. The diagram for transaction T01 as the process in the BPMN notation

4 Data Acquisition Module

The data acquisition module corresponds to the monitoring system of non-compliance at a workplace. A suitable tool to design such a system is the ADONIS software (Gawin and Marcinkowski 2013) developed by BOC([7]). To present the environment, a level model scheme forming the Business Process Management System (BPMS) paradigm is defined. An idea of the BPMS paradigm was developed in a research team of Dimitris Karagiannis from University of Vienna (Knowledge Engineering Research Group, Faculty of Computer Science, University of Vienna).[8] Hinkelman et al. (2016) presented an idea of integration of models of the enterprise architecture as well as the enterprise ontology. Modelling of processes and enterprise architecture structures is convergent with conceptualization defined in appropriate ontologies. In this paper, the ontology of the workplace OHS profile described in Section 3 is used in models of the monitoring process of non-compliance at a workplace.

7. See: https://pl.boc-group.com/.
8. See: https://cs.univie.ac.at/.

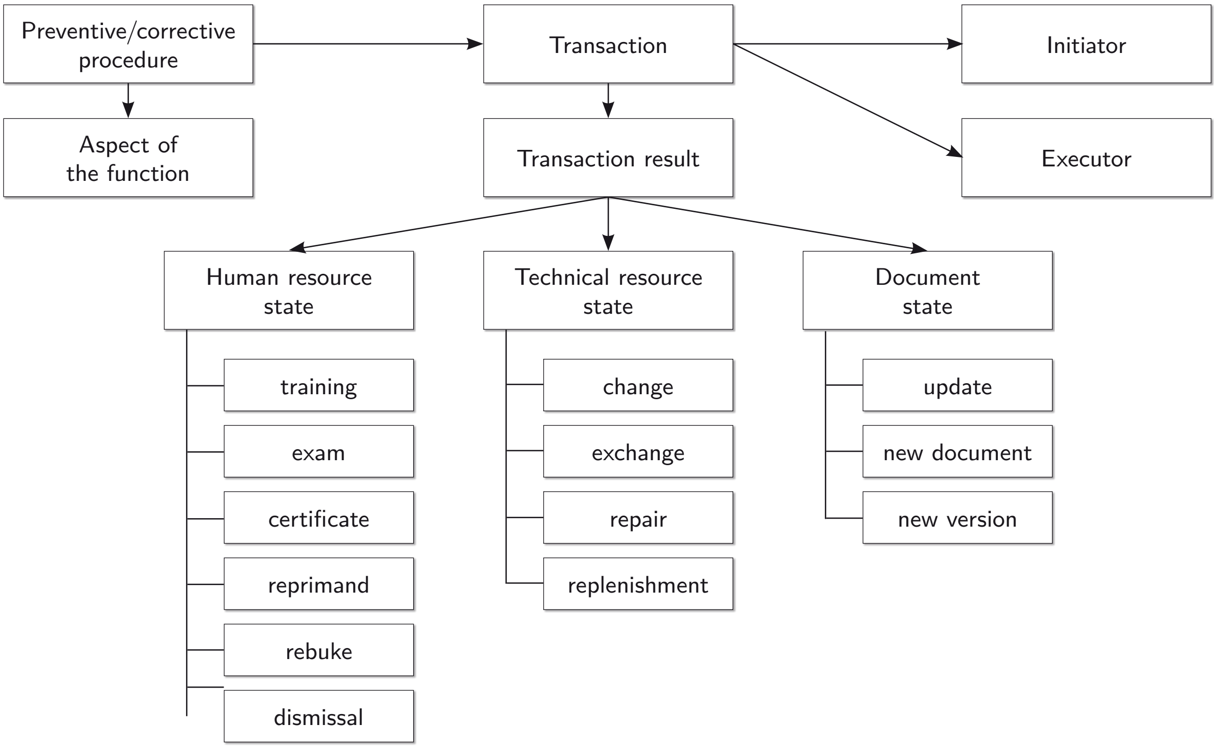

Fig. 9. The ontology of preventive/corrective procedure indexation

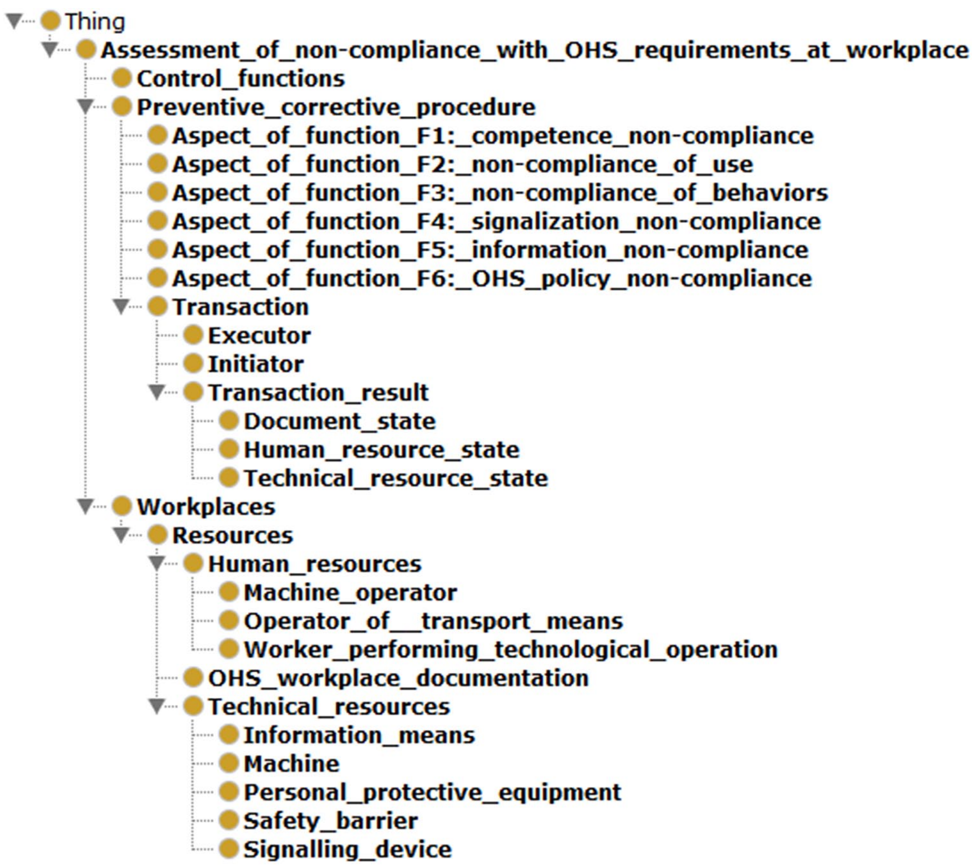

Fig. 10. The diagram of classes of the ontology OPCPI of preventive/corrective procedure indexation in Protege 5

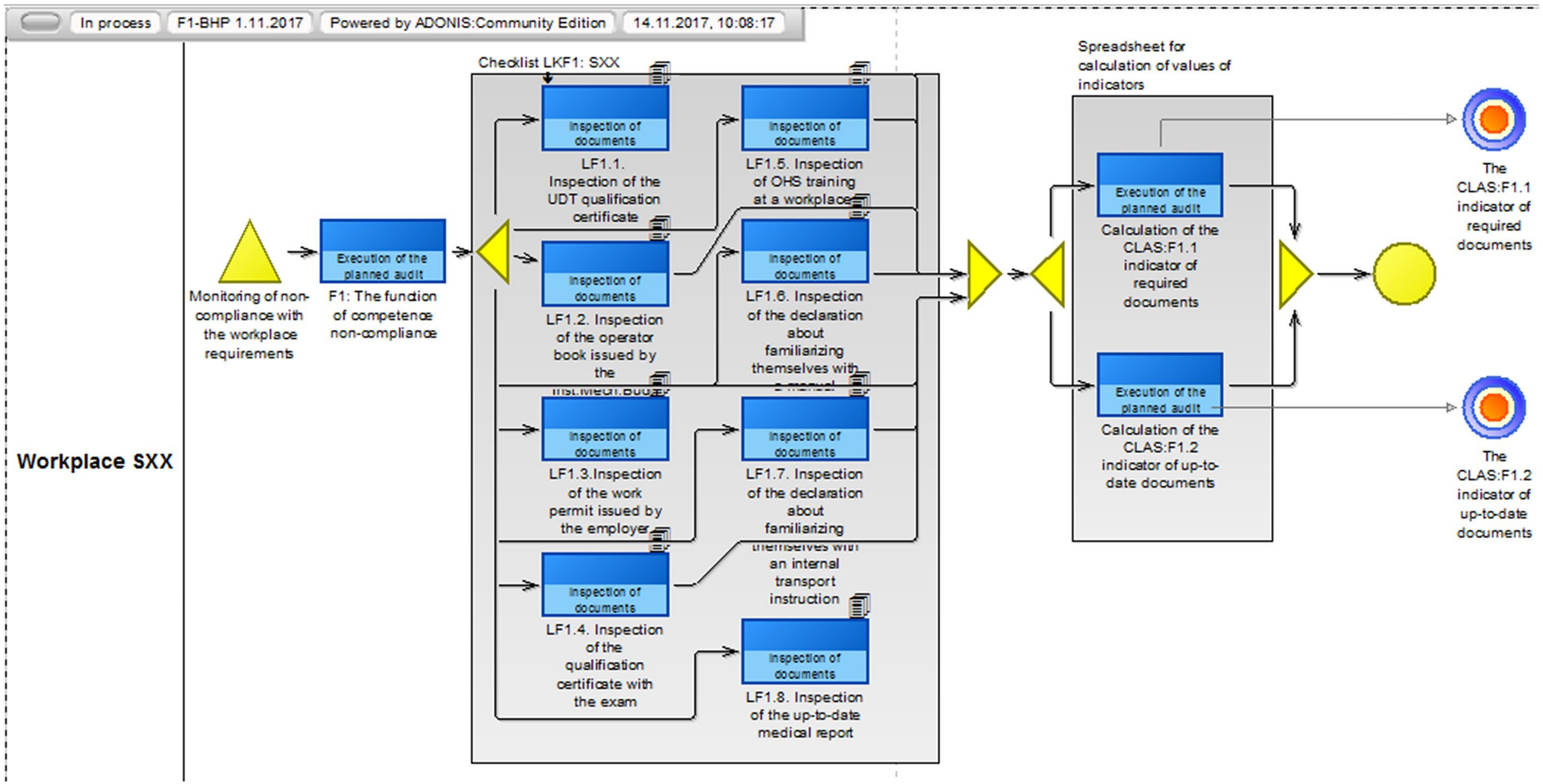

Fig. 11. The monitoring process of the OHS state at the workplace SXX in the range of function F1: inspection of competence non-compliance

In the BPMS paradigm, the following models are defined: process map, business process model, working environment model, product model, document model, IT system model, risk model, control model, resource model, data model, use case model, and BPMN models. In the ComplianceOHS-CBR system, several models are used in designing the module of non-compliance monitoring. The process of inspection of non-compliance at a workplace covered by function F1 (inspection of competence non-compliance) is shown by means of the business process model. This model allows us to determine values of two indicators: CLASS F1.1 indicator of required documents and CLASS F1.2 indicator of up-to-date documents.

CLASS F1.1: indicator of required documents = number of available documents/number of documents required by the OHS rules.

CLASS F1.2: indicator of up-to-date documents = number of outdated documents/number of documents requiring updating.

Definitions of indicators in ADONIS provide the monitoring of three states: an expected state (green color), a warning state (yellow color), and an alarm state (red color).

Figure 11 illustrates a course of the data acquisition process according to the checklist LKF1 for the workplace SXX. The checklist consists of requirements concerning complete documents for human resources of the workplace SXX. Documents are presented in the document model (fig. 12). A part of the working environment for the process of inspection is shown in the working environment model (fig. 13). In an analogous way, models of monitoring processes of non-compliance at the workplace SXX are shown in the ranges of the remaining functions F2-F6.

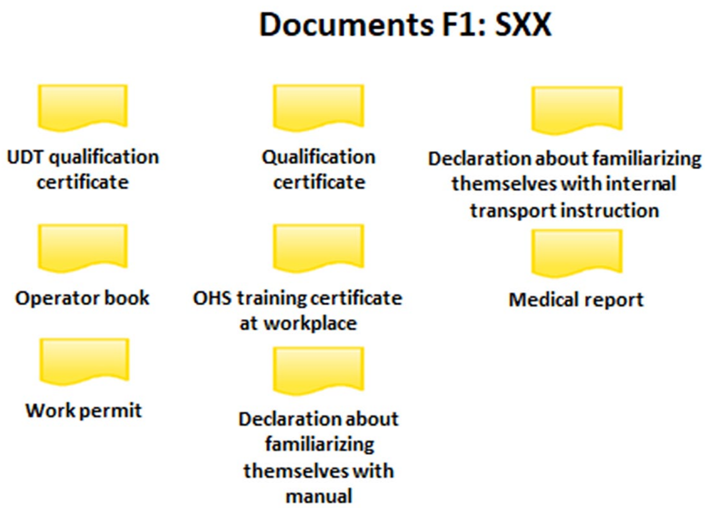

Fig. 12. The document model in ADONIS for the monitoring process of non-compliance at the workplace SXX in the range of function F1

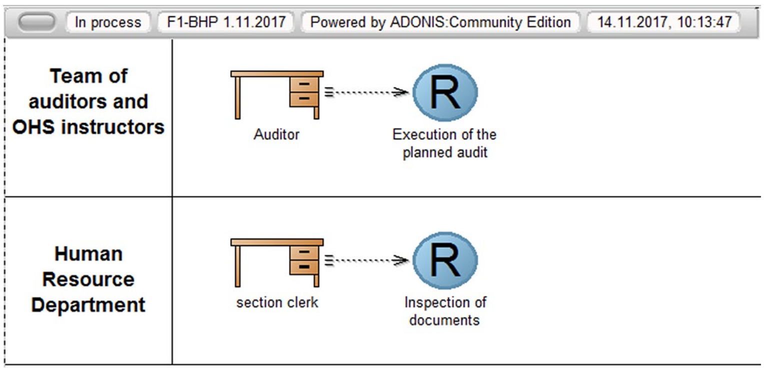

Fig. 13. The working environment model in ADONIS covering resources of inspection of documents regarding human resources of the workplace SXX

5 An Inference Engine from the Case Base

In the CBR methodology applications, it is important to use software which allows us to define cases in accordance with the domain ontology. Bergmann, Kolodner and Plaza (2005) listed the following ways of representation of cases: representation by means of feature vectors, representation by means of frames (according to the description logic notation), representation by means of object modelling, and text representation. El-Sappagh and Elmogy (2015) additionally presented representation by means of predicates, and hierarchical representation as they described, in details, semantic representation. In the semantic representation, a case is written using the OWL language.

In a number of university centers, software tools for the CBR methodology have been developed. They contain interfaces for entering new cases, indexing of cases and maintenance of a database of cases. One of the available open source systems is myCBR developed in the German Research Center for AI: DFKI. On the web page of myCBR,[9] installation instructions and documentation of the system together with the presentations are available. The system is being developed by a recognized specialist in the field of the CBR methodology, Thomas Roth-Berghofer who is the author of many publications. The myCBR system is used as an advisory system in the hydrometallurgy technology for gold production (Rintala et al. 2017) and as a part of a dynamic system for recommending teaching halls on the campus of the University of West London (Sauer, Kheirkhahzadeh, and Roth-Berghofer 2016). The myCBR system includes the editor for defining cases according to rules of creating taxonomies in the description logic format. It includes also the editor for defining and analysis of similarity measures used to retrieve cases in the reasoning process in the CBR cycle. A number of recommender systems developed using myCBR are the subject for analysis in the Ph.D. thesis of Christian Sauer (Sauer 2016).

An alternative system for the reasoning process according to the CBR methodology is jCOLIBRI2 (Recio-Garcia, Gonzalez-Calero, and Diaz-Agudo 2014) being developed by the Facultad de Informatica, Universidad Complutense de Madrid.[10] This system is adapted to the analysis of text in natural language. The engine of this system is based on a cluster analysis algorithm kNN. The system consists of all elements of the CBR cycle: retrieve, reuse (a strategy for adjustment of a case to the query or to the current signature of features of a new case), revision (making changes to the current case), retain (entering a new case into the case base). Dendani-Hadiby and Khadir (2013) presented application of the jCOLIBRI system for diagnosis support of turbine damages. In this paper, a comparison of both systems based on reasoning from cases, myCBR oraz jCOLIBRI,, is presented.

The essence of the approach presented in this paper is integration of the monitoring system of the analysis process of non-compliance with the requirements of OHS at the workplace (ADONIS software) with the system of reasoning from cases (CBR). The integration platform is based on two ontologies: the ontology OP-OHS of profile compliance with the workplace OHS requirements and the ontology OPCPI of preventive/corrective procedure indexation. Both ontologies are shown in the Protege 5 editor of the OWL language.

Conclusions

In the paper, the original architecture of the system recommending preventive/corrective procedures for workplaces is presented. These procedures are triggered by means of indicators, the values of which are determined by the monitoring system of non-compliance at workplaces. This is a new approach that uses the monitoring system to acquire the knowledge required to represent cases in the CBR methodology. In the recommender systems, the main ways of acquiring knowledge are: social networks, social portals, experts, expert portals, documentation databases, or databases with sensors. The ontologies OP-OHS and OP-CPI shown in Sections 3 and 4 will be described in detail in the author's future work. The data acquisition module taking into account all functions of identification of non-compliance will be presented in future papers. The basis for construction of the ontology of the workplace OHS profile have been shown in a previous article by the author (Andreasik 2015).

9. See: http://www.mycbr-project.net/.
10. See: http://gaia.fdi.ucm.es/research/colibri/jcolibri.

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