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BUSINESS RULES MANAGEMENT SYSTEM FOR ENTERPRISES IN IRON AND STEEL INDUSTRY

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Abstract

The central idea behind Business Rules Engines (BRE) or Business Rules Management Systems (BRMS) is that any organization has a logic that is used to carry out its operational and managerial tasks. The major objective of modern business rules management systems is to allow describing business and technological processes independently of the software system which has to be implemented. Nowadays it is possible to automate some of the processes by implementing appropriate ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), SCM (Supply Chain Managment) or WfMS (Workflow Management System) solution. But there are still processes and decisions which are non-routine or cannot be well described by an appropriate semantic language. In this paper we present the idea of Interference with Queries methodology. Based on this method we propose the framework which brings together concepts of business rules and expert systems and decision-support systems which help business experts with business rules implementation in the natural language. We formulate special, graphical language, close to natural one, for describing business and technological processes. Completeness and preciseness of processes which were described in this language, are validated by BRMS using simulation for instance. Properly described processes are ready to be used by IT system without IT experts help.

Key words: business rules management, expert systems, inference engine, metal forming technology

1. INTRODUCTION

Business rules, a well as Business Rules Engines or Business Rules Management Systems, are terms that are becoming increasingly common in today's information technology industry. Nowadays it is possible to automate processes by implementing appropriate ERP, CRM, SCM or WFM solution. But there are still some processes and decisions which are non-routine or cannot be well described by appropriate semantic language. Some of them are production or technological decisions which are very enterprise-specific. In other words they are as universal as e.g. decisions in financial or marketing area and usually depend on many non-independent factors. This kind of decisions are very popular, especially in the iron and steel industry. Examples of such decisions are as follows: selection appropriate technology to fill an order, estimation of cost of order, selection of operational parameters of technological process, re-usage redundant resources.

To support technological decisions expert or artificial intelligence systems can be used. Both of them are very similar to each other from end-user's point of view, but process of building and maintaining representation of knowledge in expert system is far to complicated to use in practice. Decline of scientific publications in area of expert systems proves it. In [1,2,13] the practical implementation of expert systems which have supported technological deci-

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sion is presented. Unfortunately, model of knowledge which was implemented in those systems, is too problem-specific, so the range of implementation is relatively narrow.

Some concepts of expert systems are used within Catia V5Rx which is offered by Dassault Systems and IBM. This solution focuses on the designing aspect of technological decision and does not take production or business aspects into account. Obviously, Catia may be integrated with ERP or CRM systems, but it applies only for groupware purposes.

So as we may see user-friendly BRMS solutions create opportunity for building effective technological decision support systems. Unfortunately, BR frameworks available on the market are still too simple to deal with complex technological decisions. In this paper, we propose completely new approach to build the model of knowledge.

2. RULES MANAGEMENT – STATE OF THE ART

In systems analysis a main goal is to collect all relevant information about the universe of discourse on a conceptual level [12]; these facts are primarily about processes and the structure and manipulation of data objects. For purpose of this work we define business rules as statements about guidelines and restrictions with respect to states and processes in an organization. Rules in active databases (cf. [3]) are structured according to the Event-Condition-Action (ECA) paradigm (cf. [4,14]). The event component indicates when a rule has to be executed, the condition what has to be checked, and the action component what has to be done. These basic component types of business rules can be further classified into several subtypes [5] which is especially relevant for the definition of a syntax for specifying business rules in a repository system.

The ECA structure allows to specify integrity constraints as well as entire processes consisting of business rules as basic elements. The possibility to specify processes using ECA rules makes business rules applicable within the concepts of business process re-engineering [6]. The importance of events with respect to processes is emphasized in [15].

3. PROBLEM FORMULATING

Before starting to build our framework it was necessary to define which kind of technological decisions are too difficult to be supported by modern information systems. Below we present results of our study.

In iron and steel industry, the creating of price list is much more difficult then in other economic sectors because of many factors like sort of raw materials, heat treatment, finishing, diameters and so on. They all have impact on price. It's obvious, that product price should be at least equal to production cost, but in metallurgy sector cost assessment is very hard and sometimes even impossible to calculate. So for this purpose we propose using set of business rules instead of common accounting principles.

Another type of decision is to estimate cost of non-typical orders. It's very risky and requires wide area of technological knowledge and experience, but completing this order may be very profitable for enterprise. Even if a manager knows non-typical products costs, he or she should take into consideration some more factors, such as enterprise image, production capacity or enterprise costs. So without business rules management systems appropriate assessment of cost is probably impossible.

Verifying feasibility of order is another typical day-to-day decision. Nowadays, one and only reliable way of making this decision is to develop technology steps before receiving the order. It is very time consuming so time between placing the order and enterprise response takes longer.

A charge selection affects product price, and probability of rework or achieving appropriate properties of final product. Also input selection is strictly connected with technological parameters, costs and features of final products. Therefore finding near optimal solution is almost impossible because of some many above mentioned factors.

Order cancelation, better utilization of production capacity, retrain in part of order – these are roots of creating redundant materials. Reusing or selling this materials reduces inventory costs and financial fluency. To sell redundant materials manager should first find group of appropriate orders, analyze worthwhileness of materials and check if redundant materials may be reworked to achieve appropriate properties.

The connections between aggregates in metallurgy are very complex. Some of the most important aspects of scheduling jobs in such enterprise are: work continuity constraints, long time and cost of start/stop of the production process, minimal work time, sequence of orders within the campaign, and others. Planning and scheduling methods and techniques are well-known and widely use in practice, although there are no methods to deal with failure of equipment, because making appropriate decisions requires to analyze large number of relationships. So machine failure causes that master production plan has to be changed which is much more complicated then creation of new one. There are no appropriate algorithms which deal with this problems. So without business rules it is impossible to make appropriate decision. Failures of equipment causes problems in appropriate human resource management. So optimal human resource allocation require considering many conditions.

Fault and losses diagnosis is usually based on simulation or expert knowledge. Simulation methods are usually more adequate and reliable, but are time consuming. Experts make faster decisions, but they are more error-prone. So in this area some expert systems are used, but not in such complicated area like iron and steel industry.

4. INFERENCE WITH QUERIES METHOD FOR BUSINESS RULE MODELLING

In our framework we use as an inference engine for business and technological rules management the original method elaborated in the Faculty of Management of AGH (University of Science and Technology, Kraków). The source of IwQ method came from considering the possibility of developing tools for modelling business rules management systems (BRM). It turned out that decision problems depicted by business rules usually belong to the class of unstructured problems. The knowledge about those problems cannot be represented in a procedural manner. As a result, only those methods of knowledge representation, which allow building declarative model of decisions, can be used. One of these methods is a frame-based approach to knowledge formulation [11]. Our solution is very close this idea but instead of specific relations between atomic data implemented by frames and hierarchy facets ("A-kind-of"), as well procedural facets (e.g. "If-needed", "If-created",. . .) we use mechanisms of relational database (relationships, triggers, stored procedures etc).

The central entity containing the information about all attributes, values, constants and facts in Knowledge Base is entity:

Facets={FacetsName, TableName, SelectedColumn, ValueColumn, CollectionIndex, FunctionName}

Each object in knowledge base is identified by the unique *FacetsName*. The facets can represent variables which values are changed by the inference engine or are given from external inputs, constants and atomic values given by SQL queries from bounded tables or joins. In case of facets bounded with RDBS tables, the table name (*TableName*), a name of the column to return from a table (*SelectColumn*), optionally a name of the column containing the auxiliary value returning from a table (*ValueColumn*), the index of the collection of returned rows (*CollectionIndex*) and the name of the function used in a select expression, (*FunctionName* e.g. *SUM*, *MAX*, etc) are specified. In case *TableName* column contains null value the system identifies variable or constant. The *FacetsValue* contains the current value of the facet. For each facet bounded with RDBS tables we can specify an unlimited set of search conditions contained in entity:

FacetsWhere = {FacetsName, ParametersName, Operator, ColumnName}

The condition is described by the column name in the table bounded with parent facet (*ColumnName*), the relational symbol (*Operator*) and the name of the facet which is the right hand predicate of search condition (*ParametersName*).

Our model of the rule-based system use an extended form of the rules including both control statement and dynamic operations. All elements of this formula are represented by relations. Generic form of a rule can be presented as follows:

$rule(i) : \Lambda(LeftHand_{RuleNumber=i})$
$communicate(RHAsk_{RuleNumber=i \text{ and } TrueOrFalse = TRUE})$
$modify(RHOperations_{RuleNumber=i \text{ and } TrueOrFalse = TRUE})$
$execute(RHProcedure_{RuleNumber=i \text{ and } TrueOrFalse = TRUE},$
$ProceduresParameters_{ProcedureNumber=PrNo})$
next(j)
else
$communicate(RHAsk_{RuleNumber=i \text{ and } TrueOrFalse = FALSE})$
$modify(RHOperations_{RuleNumber=i \text{ and } TrueOrFalse = FALSE})$
$execute(RHProcedure_{RuleNumber=i \text{ and } TrueOrFalse = FALSE},$
$ProceduresParameters_{ProcedureNumber=PrNo})$
else(k)
where
$LeftHand_{RuleNumber=i}$ are all tuples from *LeftHand* relation in form of

LeftHand = {RuleNumber, FacetsNameLH, LHSource, FacetsNameRH, RHSource, Operator}

which fulfil the condition *RuleNumber* is equal to *i*

Λ is the conjunction function returning true value when all logical values of tests in form of *FacetsNameLH* $_{LHSource}$ Operator *FacetsNameRH* $_{RHSource}$ are true communicate is the method performing the dialog with the user using the following relation

RHAsk = {RuleNumber, TrueOrFalse, InputFacet,OutputFacet, InfoTextFacet, ConstText, AskType}

modify is the method which changes the proper facets values using the relation:

RHOperations = {RuleNumber, TrueOrFalse, InputFacet, InputSource,OutputFacet, OutputDestination, Operation, OperationArgument}

execute is the method performing external procedures using two relations

RHProcedure = {ProcedureNumber, RuleNumber, TrueOrFalse, ProcedureName, ProcType, ProcAddress}
ProceduresParameters = {PrNo, ParameterName, ParameterValue}

The mentioned above relations can be describe as follows: *LeftHand* defines an unlimited set of preconditions containing names of left hand condition facets, right hand condition facets and the relational symbol (*Operator*); because a facet returns two values: the value in specified column and the index of row, columns *LHSource* and *RHSource* specify which value will be taken for examination.

In *RHAsk* relation we can specify the name of the facet for each rule to be determined by user (*InputFacet*), a name of the facet which has to be displayed on the terminal (*OutputFacet*), a name of the facet containing the value to be shown on the terminal (*InfoTextFacet*), the constant text to be shown on the terminal (*ConstText*) and a type of the form (*AskType*). The System provides a set of forms for different methods of dialog, e.g. an atomic value input, selection from the list, selection multiple value by checkbox, presentation of an atomic value or a list of values, etc.

Each row of *RHOperations* table includes names of input and output facets (*InputFacet*, *OutputFacet*), information which output of the facet is to be taken into operation - value or collection index (*InputSource*, *OutputDest*) and the name of the predefined two operation arguments (*Operation*) with its argument (*OperationArgument*) being a facet's name; the last two data are necessary when a new value of output variable or fact is a result of a simple arithmetic operation or a mathematical function.

RHProcedure identifies the external procedures by name (*ProcedureName*) and type (*ProcType*), e.g. SQL procedure, the objects method got from an assembly etc; in column *ProcAddres* we can add an information necessary to find the source of procedure, e.g. the assembly name.

For each procedure we can specify the set of needed arguments in child entity *ProceduresParameters* containing the name of the parameter using by external procedure (*ParameterName*) and the name of the facet representing the current or returning value of the parameter.

As well as the rules are stored in relation:
Rules = {RuleNumber, TrueRuleNumber, FalseRuleNumber}
this relation contains rule number and the control part of the rule (*next(i)* as *TrueRuleNumber* and *else(i)* as *FalseRuleNumber*).

There are some differences between IwQ and the other methods. They are as follows:

- Rules are stored in relational database model. So users can easily and quickly edit them without restriction to number of conditions or conclusions.
- In case of optimize rules SQL mechanism may be used.
- The facets can be imported from any kind of external data source which supports SQL language.
- The deduction is scheduled by rules (thanks to *else* part). Although it restricts possibility of knowledge generation and makes modeling harder however it creates possibility to use proposed method as an extension of SQL language.
- A set of rules which are connected by addresses and are launched on the right side is a core of universal tool for modeling decisions and processes.

5. PREVIOUS EXPERIENCES

The IwQ method was proven to be used useful in technological decision support system.

In our previous researches [7] the application of IwQ as a shell tool for Expert Systems was verified. We have stated that the method allows to decrease a number of rules, which can be replaced with SQL queries. Moreover, it is possible to edit rules, as well as information sources (facts and variables) in users friendly manner [8].

The main aim of creating IwQ method is modeling complex information systems. The method is useful for these complex problems, which deal with the effectiveness of collecting and making information in workflows accessible, but still they require solving decision problems. Examples of these problems are as follows: manufacturing plan optimization, job shop scheduling and others, and operational research problems which at the same time they must be tested in connection with mastering workflows, business process management and IT. Designing Supply Chain Management System is just one of those problems. The procedure of realizing purchases in a large multinational production company supported by the method was presented in [8]. The tool made in accordance with IwQ method enables to construct and test many alternatives of the designed or improved system, taking into consideration both different decision rules or processes and decision-making flowcharts.

One of the main problems which makes modeling of manufacturers behavior difficult is how to write the rules describing production plan for ordered products. When a particular production plan can be assigned to every offered product a problem of choosing a right technique is reduced to matching the classes describing order lines, products and operations. However, when variant solutions exist and they depend on the current manufacturing capabilities and specific requirements of the customers, complex business rules need to be described and a sophisticated inference engine must be used. In [7] the solution of such a problem was presented.

The IwQ method was also tested by solving technological problems. In our researches we verify the possibility to explore the technological knowledge in operational and static problems using IwQ inference engine. In [10] we present the application which uses IwQ method for the selection of casting process taking into account the economic and technological customer needs. Similar problems but concerning forging process was presented in [9]. Additionally we have tested the possibility to use IwQ as a tool for technological knowledge of forging process exploring.

6. CONCLUSIONS

The modern business rules management systems is to allow describing business and technological processes independently of the software system which has to be implemented which is one of key aspects in supporting operational decision. Specific aspects of iron and steel industry cause that idea of IwQ methods looks very promising. Now based on this method we prepare the framework which brings together concepts of business rules and expert systems and decision-support systems which help business experts with business rules implementation in the natural language. We formulate special, graphical language, close to natural one, for describing business and technological processes. Completeness and preciseness of processes which were described in this language, are validated by BRMS using simulation for instance. Properly described processes are ready to be used by IT system without IT experts help.

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SYSTEM ZARZĄDZANIA REGUŁAMI BIZNESOWYMI DLA PRZEDSIĘBIORSTW Z SEKTORA HUTNICZEGO

Streszczenie

U podstaw systemów zarządzania regułami biznesowymi leży założenie, że każda organizacja posiada pewną logikę biznesową, którą wykorzystuje do osiągania swoich celów operacyjnych i strategicznych. Współczesne systemy zarządzania regułami biznesowymi dążą do takiego opisu tej logiki, by możliwa była jej implementacja w dowolnym systemie informatycznym. O ile procesy rutynowe można zamodelować wykorzystując odpowiednie istniejące rozwiązania ERP, CRM, SCM czy WFM, o tyle wiele procesów i decyzji, występujących szczególnie w obszarze technologicznym, nadal czeka na odpowiednie metodologie. W artykule prezentujemy wykorzystanie metodologii IwQ do stworzenia platformy łączącej w sobie koncepcje reguł biznesowych oraz systemu wspomagania decyzji, której celem będzie implementacja reguł biznesowych w języku graficznym o składni bliskiej naturalnemu. Kompletność i precyzja opisu procesu w tym języku może być walidowana np. przy pomocy symulacji, po czym odpowiednio opisane procesy są gotowe do implementacji bez pomocy personelu informatycznego.

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