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Measuring Knowledge with Workflow Management Systems

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Measuring Knowledge with Workflow Management Systems

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Abstract

Expert knowledge is captured in the process design. In organisations knowledge becomes embedded in routines, processes, practices as well as norms and can be evaluated by decisions or actions to which it leads, for example measurable efficiencies, speed or quality gains. Knowledge develops over time, through experience that includes what we absorb from courses, books, and mentors as well as informal learning.

In this paper we analyse workflow history and demonstrate that workflow management systems enable knowledge measurement.

1 Introduction

Workflow management systems (WFMS) completely define, manage and execute workflows (computerised automation of a business process, in whole or part) through the execution of software whose order of execution is driven by a computer representation of the workflow logic [1], [15], [13]. WFMSs carry out business processes by interpreting the process definition. The major advantage of WFMSs is the separation between process logic and task logic, whereby the latter is embedded in individual user applications [12]. This separation allows the two to be independently modified as well as analysed and provides the potential to support the structural change from a functional to a process-centered organisation.

WFMSs store histories of all process instances in log files, recording all state changes that occur during a workflow enactment in response to external events, or control decisions taken by the workflow engine. Audit data, is the historical record of the progress of a process instance from start to completion or termination [15] and enables the analysis of process performance. Audit data is to be used in conjunction with meta data [14], which is defined in the build time component of the WFMS. Meta data, is the corresponding process definition of a process instance and describes for example the organisation hierarchy or target performance indicators.

A workflow participant or the workflow engine creates a new process instance and at the same time the workflow engine assigns the instance a state. Basically, workflow participants can explicitly request a certain process instance state. When a process is running, the workflow engine creates sub-process, activity or work item instances according to the process definition and assigns work items to the process participant's work list. The user performs the assigned task and after completion the work item is withdrawn from the work list.

Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers [4]. In organisations knowledge becomes embedded in routines, processes, practices as well as norms and can be evaluated by the decisions or actions to which it leads, for example measurable efficiencies, speed or quality gains [4]. As WFMSs track performance indicators like process cycle time, cost, failed or successful instances and the workflow participant responsible for an instance, they enable knowledge measurement.

In this paper we discuss the ability of WFMSs to measure knowledge and present the capabilities of the process warehouse[1] supporting this undertaking. In section 2 we present the basic concept of the process warehouse and in section 3 the capabilities of WFMS to measure knowledge are discussed. Section 4 applies these results to the process warehouse. Section 5 comprises barely available related work and section 6 is a summary.

[1] The Process Warehouse is a research prototype developed at the Institute of Software Technology, Vienna University of Technology.

2 The Process Warehouse Approach

Workflow-based process controlling has received relatively little coverage in the related literature [16]. Research prototypes and commercial products in this area are built on top of relational databases and focus primarily on monitoring a small fraction of performance measures within a limited time frame. The analysis of workflow history, which is stored on instance state level, requires a lot of complex queries and transformations that cause a negative impact on the database performance. Operational workflow repositories store workflow histories only for a few months, but analysing data patterns and trends over time requires large volumes of historical data over a wide range of time. Several years of history would be useful for such analysis purposes. In order to avoid these shortcomings (discussed in [6], [7], [8]) we apply a data warehouse approach, which is dedicated to analytical processing and which is well suited for fast performance in mining applications towards bottleneck diagnosis and other important decision supporting analysis.

The main objective of a performance measurement system (PMS) is according to Kueng in [9] to provide comprehensive and timely information on the performance of a business. This information can be used to communicate goals and current performance of a business process directly to the process team, to improve resource allocation and process output in terms of quantity and quality, to give early warning signals, to make a diagnosis of the weaknesses of a business, to decide whether corrective actions are needed, and to assess the impact of actions taken. A PMS ought to represent all goals and structures of an organisation. These are turned down into well-defined performance indicators, which are fundamental for the process warehouse design, as the analysis and improvement capability of the system depends highly on the integration of these aspects as well as on the transformation into an adequate data model.

Data from additional source systems e.g. Business Process Management Systems (target values, process definition), Enterprise Resource Planning Systems (organizational model, position profile, employee qualification, education, pay scheme), strategic data sources (balanced scorecard, key performance drivers and indicators) and other data sources (staff opinion surveys, customer surveys, special product offers, product announcements, stakeholder analysis, marketing and advertising events) lead to a very balanced and comprehensive performance measurement system. Our intent is to provide a decision support approach to business process control data and to exploit the analysis capabilities through the combination with business data. In this paper, we focus on the workflow audit trail as the main data source.

We define the process warehouse (PWH) as a separate read-only analytical database that is used as the foundation of a process oriented decision support system with the aim to analyse and improve business processes continuously. It enables process analysts to receive comprehensive information on business processes very quickly, at various aggregation levels, from different and multidimensional points of view, over a long period of time, using a huge historic data basis prepared for analysis purposes to effectively support the management of business processes [11].

The analysis of business processes requires the representation of theoretical aspects in the basic concept, which we capture in four views [11]. The Business Process View completely disregards the functional structure, but fully represents the approach of process-centered organisations and looks horizontally across the whole organisation. The analysis of this view focuses on the process as a complete entity from a process owner's point of view. The process owner or manager is an individual concerned with the successful realisation of a complete end-to-end process, the linking of tasks into one body of work and making sure that the complete process works together [3], [5].

Business processes flow through several organisational units and cross a lot of responsibilities; it is obvious that the process reflects the hierarchical structures of the organisation [10]. The analysis of this view addresses the organisational structure of a business process and the fact that business processes, which cross organisational boundaries very often tend to be inefficient because of changing responsibilities or long delay times [10]. Therefore, the analysis of the organisational structure is an important aspect of process improvement, as it supports the detection of delay causing organisational units. The Organisational View supports the analysis of these aspects.

The Improvement Support View is based on the histories of several instances together. The aggregation of instances aims to identify major performance gaps and deviations, which give evidence of improvement needs. As single instances do not have an impact on aggregated performance, gaps reflect fundamental performance problems or process design shortcomings. The Information Detail View is targeting process, activity and work item information on instance level or slightly aggregated level. It enables the analysis of instance development over time and supports to determine the cause of performance gaps and deviations.

3 Capabilities of WFMS to measure KN

Knowledge (KN) is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information [4]. It originates and is applied in the minds of knowledgeable people. In organisations knowledge becomes embedded in routines, processes, practices and norms. Knowledge can be evaluated by decisions or actions to which it leads, for example measurable efficiencies, speed or quality gains. Therefore, we can measure knowledge with WFMSs. Davenport and Prusak discern in [4] between knowledge that is fully embedded in the process design and the human knowledge that keeps the process going. This knowledge judgment correlates directly with the workflow definition in the build-time-component of a WFMS and the workflow instantiation in the run-time component of a WFMS.

Berztiss stated in [2] that there are three kinds of knowledge associated with WFMS. The first relates to the setting up of a business process. The second consists of the information that the WFMS has to access in its regular mode of operation. The third one relates to the fast changing business world and that the need to monitor the environment regularly in order to adapt the process design in response to external changes. In other words, the first and the third kinds of knowledge relate to the implementation and maintenance of the workflow. The second kind refers to the operational knowledge of the business process.

Expert knowledge is captured in the process design. This knowledge can be measured firstly by the identification of performance deviations and secondly by comparison with competitors or recognised benchmarks. When a business process improvement slightly changes the workflow design, for example through a new software application, the workflow will take a little longer in the initial phase, but after a learning phase the process performance should be better than before. Basically, when the overall quality has improved, it is shown that the designer captured new knowledge in the process architecture.

Knowledge develops over time, through experience that includes what we absorb from courses, books, and mentors as well as informal learning [4]. Knowledge works through rules of thumb: flexible guides to action that developed through trial and error, over long experiences and observations. Rules of thumb are shortcuts to solutions to new problems that resemble problems previously solved by experienced workers. Those with knowledge see known patterns in new situations and can respond appropriately. They do not have to build an answer from scratch every time. So knowledge offers speed, it allows its possessors to deal with situations quickly, even some complex ones that baffle a novice. The development of performance over time corresponds to the development of knowledge and can therefore be measured.

A process performer, for example, who has just joined a company or started a new job will need a considerable amount of time to perform a work item, but after some days the person should become faster due to gained experience. A poor or unskilled process performer, who has finished an education program, should increase his/her performance because of improved skills. Quality and quantity of work should increase with experience. Knowledge generation can be measured through the improvement of experience and skill development over time.

The continuous reduction of process, activity or work item duration represents the development of a learning participant. A very high process duration represents either an indicator for further education in order to improve the skill level or that the employee is not suitable or motivated for the job at all and a job rotation initiative has to be considered. Constant process durations and low deviations represent a well-qualified process participant and a well-designed process.

Employees face various working periods, e.g. at peak times the workload is higher or during vacation periods a stand-in concept is required. The analysis of workflow history enables the detection of such unbalanced process resources and supports to adjust these resources to external requirements. A more customer oriented resource allocation represents an added knowledge to the process design.

Knowledge is not bound to a high level occupation, even assembly line work, often considered merely mechanical, benefits from the experience, skill, and adaptability of human expertise [4]. Hence, even production workflow management systems support the measurement of knowledge.

4 Measuring Knowledge with the PWH

4.1 Business Process Analysis

In this section we demonstrate the knowledge measuring capabilities of the process warehouse with an example business process of an organisation in the insurance sector. The solicited process is the insurance selling process, which has been reengineered in the sales department recently.

Figure 1 displays the development of the sales process duration and deviation over time. Before the reengineering took place the process always met the target duration precisely. After reengineering the duration increased, because workflow participants had to become familiar with the new application that supports the new selling process. Following the development of the duration curve, one can see that the process duration is steadily declining:

the knowledge of workflow participants is developing over time, through experience! If there is a need for more detail, for example to analyse the knowledge development of individuals, groups or departments one has to add the Organisational View. As the reengineered selling process is faster than the previous selling process, it is for sure that new knowledge is captured in the process design. Even though this can be observed in Information Detail View, embedded process knowledge is pictured much more significant in the Improvement Support View.

The main benefit of the process warehouse for knowledge measurement is that the Information Detail View and the Improvement Support View represent the development of knowledge respectively the expert knowledge captured in the process design. Thus, the PWH does not require any further extension to measure knowledge.

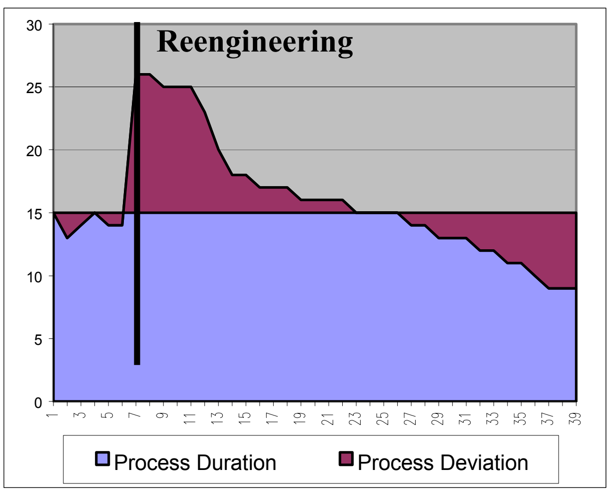

Figure 1: Selling Business Process Performance

4.2 Workload Analysis

A user's work list can consist of several work item instances, categorised by priorities. A work item instance can be assigned to several participants. When a user selects a work item, it is withdrawn from all work lists. If the work item is not completed, it will be reassigned to all work lists. Employees face various working periods, e.g. at peak times the workload is heavier and during vacation periods a stand-in concept is required.

In organisations groups of people work together and workload has to be balanced between group members. The workload cube (see Figure 2) enables the detection of unbalanced stand-in concepts within groups or the analysis of individual participants' workload. When all group members face an extremely heavy workload, a new schedule or even an additional employee is required. When group members face different workloads, a more balanced stand-in or work schedule concept is required. The need for a process redesign or a resource reallocation reveals that the knowledge in the process design is not appropriate to the current environmental situation and ought to be improved.

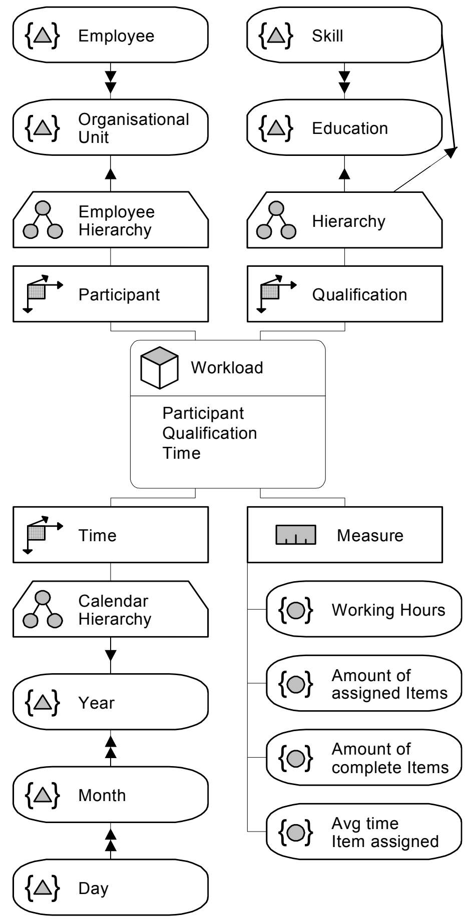

Figure 2: Workload Cube in ADAPT notation

At the beginning of training the overall performance of a process performer is very low. The qualification dimension enables the analysis of workload by skill level (e.g. beginners or professionals) in order to distinguish between overload or orientation phase. A very high amount of assigned work items, a high average duration of work items waiting in the work list for processing, long working hours and a small number of completed work items characterise beginners. After some time of training a familiarisation with work will commence. The workload fact table enables to monitor the knowledge creation process of new, inexperienced workflow performers. The pace of it depends on prior experience, skill, education and expertise.

5 Related Work

Workflow Management Systems are lacking a comprehensive analysis component in general and knowledge-measuring capabilities in particular. PISA (Process Information System with Access) is a process analysis tool developed at the University of Muenster, Germany [16] that offers some knowledge-measuring components. PISA evaluates audit trail data of the workflow management system MQ Series™ from IBM and uses process definition data generated by the process-modelling tool ARIS Toolset™. Workflow audit trail data is imported into a read-only relational database and is stored on workflow instance state level, whereas the ARIS database is accessed during process analysis via ODBC. PISA offers capabilities to measure a workflow participant's learning curve as well as the balanced assignment of resources but does not generally focus on knowledge measurement.

Alfs T. Berztiss published in [2] a position paper on WFMS and knowledge. He examines how knowledge management relates to the development and operation of WFMS from a broader perspective. The work emphasises on the construction of workflows and how this can be supported with knowledge management approaches. The retrieval of knowledge from workflow history is not addressed at all.

6 Conclusion

In this paper we discussed the capabilities of WFMSs to measure knowledge. Knowledge is either captured in the process design or develops over time, through experience that includes what is absorbed from courses or books. According to Davenport in [4], knowledge is not bound to a high level occupation, even assembly line work, often considered merely mechanical, benefits from the experience, skill, and adaptability of human expertise. Hence, workflow management systems support the measurement of knowledge.

We demonstrated how to measure knowledge with the process warehouse. The Information Detail View and the Improvement Support View represent the development of knowledge respectively the expert knowledge captured in the process design. The Organisational View measures knowledge of individuals, groups or departments and the Process View focuses on business processes as a complete entity. The main benefit of the PWH is that the knowledge measurement capability is fully integrated in the design and does not require any further extension.

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