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Competency-Oriented Business Process Analysis

A Model-based Approach

Traditionally, business process analysis is primarily concerned with the identification of structural weaknesses, inefficient capacity utilisation or IT deficiencies. Despite this well-founded knowledge about process performance, and despite the increasingly recognized relevance of human capital for business performance, business process analysis efforts rarely touch human resources – except for downsizing or layoffs. The objective of this paper is to extend traditional business process modelling and business process simulation by competency requirements and their impact on process performance. By doing so, business process performance can be improved through the integration of competency requirements into process design. The approach addresses the need to derive competency requirements from business processes in order to facilitate the alignment of employee competency profiles with business roles (staffing) as well as the effective closure of business-relevant competency gaps through tailored learning processes (business-driven personnel development).

1 Introduction

The concept of business process analysis has been used for almost three centuries in almost all types of industries. Initially brought up by Hammer and Champy as revolutionary business process reengineering (BPR) in the 1980s [HaCh03], it has reached acceptance as a continuous management concept throughout industries. According to the philosophy of continuous process improvement (CPI) business processes shall be constantly analysed for potential improvements [Sche99]. Traditionally, business process analysis is primarily concerned with the identification of structural weaknesses, inefficient capacity utilisation or IT deficiencies. Business processes can be streamlined by remediating or reducing bottlenecks, redundancies, or downtimes. Integrated enterprise systems such as Enterprise Resource Planning (ERP) systems provide a mean to mitigate media or system disruptions and rationalize processes.

Business process models support process optimisation efforts by graphically mapping their logical and timely flow of control and information. They also serve as a basis for simulating business process performance. Process simulation software provides the possibility to experiment with alternative business process designs and project their impact on process performance.

Despite this well-founded knowledge about business process management, and despite the increasingly recognized relevance of human capital for business performance, business process analysis efforts rarely touch human resources – except for downsizing or layoffs. At the same time, training and learning management functions are increasingly asked to justify their activities and costs in a business context. It is obvious that the key to strategic personnel development is the alignment of employee competencies with business objectives. Given the central role of business processes for enterprise strategy as well as the existing organisational aspects in business process modelling methods, the gap between business process management and learning management becomes apparent.

This paper presents an approach to synchronize learning processes with business processes. The objective is to extend traditional business process modelling and business process simulation with competency requirements and their impact on process performance. Thus, business process performance shall be improved by integrating competency requirements into process design. Many of the common modelling methodologies are primarily concerned with the flow of activities and required resources for their execution but less concerned with knowledge and competencies as an influencing factor of process performance. The approach presented in this paper extends the traditional view on business process analysis by taking competencies and their impact on the effectiveness and efficiency of process execution into account.

The paper is structured into five sections. After this introduction, Section 2 outlines the process-oriented learning lifecycle which puts the presented approach into the context of the European research project PROLIX. Section 3 introduces a competency-oriented modelling method for process modelling. It introduces ARIS as a methodological basis, extends it by competency-specific model and object types and integrates them into EPC diagrams in order to specificy competency requirements within a business process. Section 4 continues the approach of competency-oriented business process analysis and describes how business process models must be configured in order to include competencies as process performance parameters. The approach is illustrated by a prototype. Section 5 summarizes the paper and gives an outlook regarding future research.

2 Process-oriented Learning Lifecycle

Competency-oriented Business Process Analysis is a major component of the complete process-oriented learning management cycle as it is conceptualized and implemented by the European Research project PROLIX (www.prolix-project.eu). The cycle (Figure 1) is based the notion that learning process design must follow competency requirements identified in business processes. The underlying assumption is that only learning processes that convey those competencies to employees that are required by their employee-specific role in business processes will have a positive impact on business process performance. The cycle is structured into six major phases, starting with business process and competency gap analysis which feed into learning scenario modelling and learning process design. The execution of learning processes by the individual is followed by performance monitoring activities that evaluate the impact of learning on business processes. The cycle closes with the business analyst comparing the business outcome of the learning process (as it is monitored by the previous phase) against the initial business process need. Therefore, the business analyst visualizes and analyzes the performance results from the monitoring phase. Unless the results are satisfactory, business processes and/or learning processes are adapted and optimized according to the analysis before restarting the PLLC.

In this cycle business process analysis comprises the modelling or business processes including the identification of competencies or roles required to carry out the functions of a business process and the subsequent (optional) simulation of this business process.

Integrating all phases into a closed cycle is not only a methodological challenge but also a technological one. Whereas this paper focuses rather on methods of competency-oriented business process analysis than on technical integration, the implementation of competency-oriented analysis is prototypically demonstrated in an existing business process environment, complemented by a simulation configurator (see Section 4).

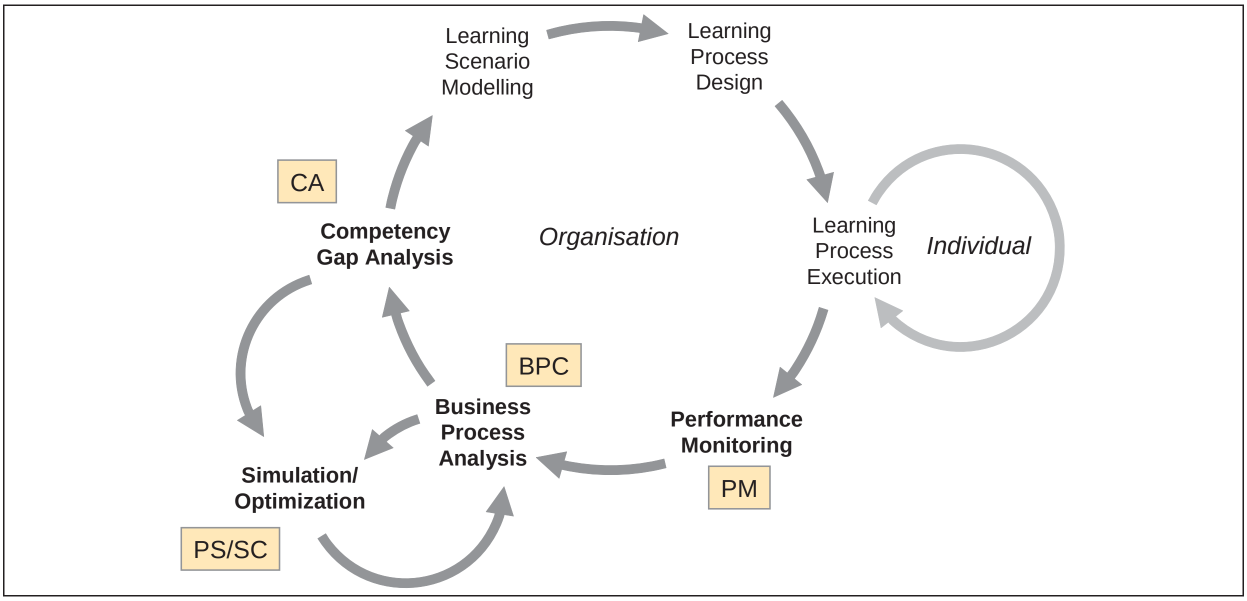

Figure 1: Process-oriented Learning Lifecycle

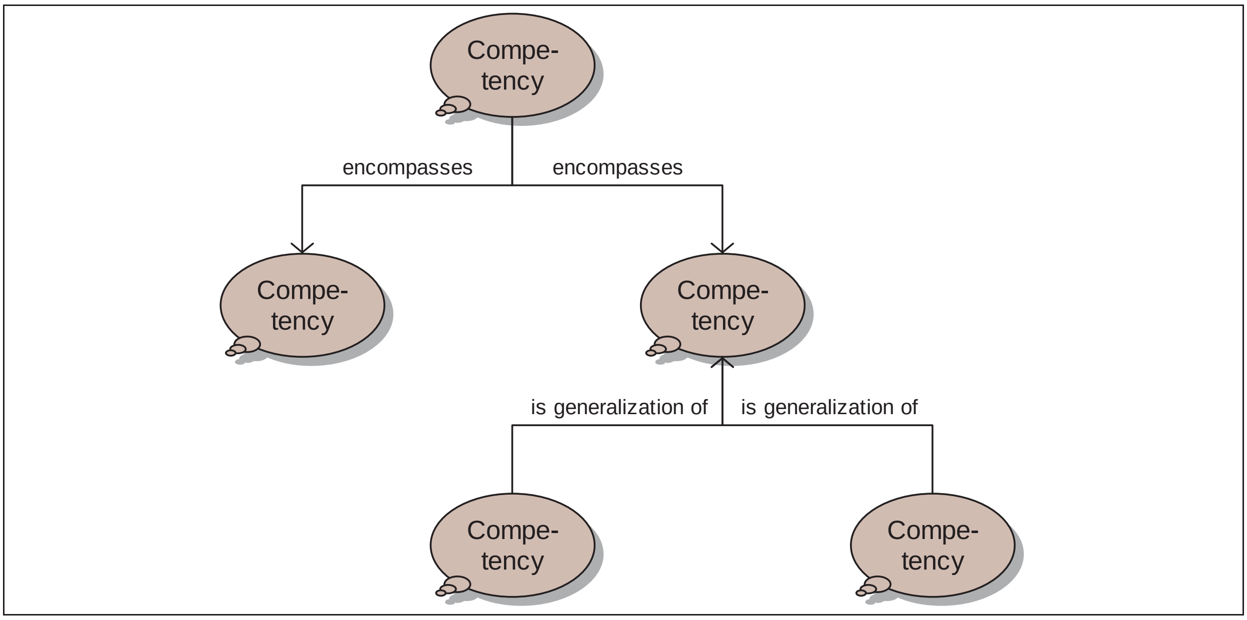

Figure 2: Competency Structure Diagram

3 Competency-oriented Business Process Modelling

3.1 Methodological Basis

Given the wide-spread acceptance of existing process modelling methods, the objective was not to create a novel competency-oriented modelling method but extend an existing standard. Amongst others[1], the ARIS methodology qualified best for supporting the competency-enriched process modelling approach [Sche99], because:

- ARIS provides knowledge modelling facilities which are close to what is required for competency modelling in the context of business processes [AlSc99].
- The semi-formal approach of ARIS suits the requirement of easily understandable modelling for non-technicians such as HR analysts while being precise at the same time.
- ARIS models and especially its core process modelling method Event-Driven-Process-Chains (EPC) are well accepted and adopted in enterprises to the extent of a de-facto standard [KeNü+92].
- Extensive support for modelling organisational structures is provided by the ARIS perspectives.
- The ARIS meta model allows for easy extension of the methodology with new models and objects through the view-oriented framework.
- EPCs can be converted to machine-interpretable process models (e.g. XPDL or BPEL).

3.2 Competency Modelling

Competency modelling is concerned with the documentation and presentation of competencies, competency sources and competency sinks within an organisation. The creation of such models is an important precondition for understanding an organisation's competency situation and needs. It reduces complexity and enables improvements in process performance. For competency modelling the Competency object type and the model types Competency Structure Diagram and Competency Map are introduced. They are derived from the existing ARIS model types Knowledge Structure Diagram and Knowledge Map.

A competency is regarded as a skill or knowledge which can be defined independently of an individual or group. A competency profile consists of a structured collection of competencies. Each competency can occur in multiple proficiency levels. Thus, a competency profile varies in terms of competency levels assigned to the subordinated competencies. A

1.An in-depth study compared the adequateness of a series of modelling methods including UML Activity Diagrams, Business Process Modelling Notation (BPMN), Knowldge Management Description Language (KMDL), PROMOTE, GPO-WM and ARIS ([Abec02], [GrMü+05], [Heis05], [Whit04], [Whit06]).

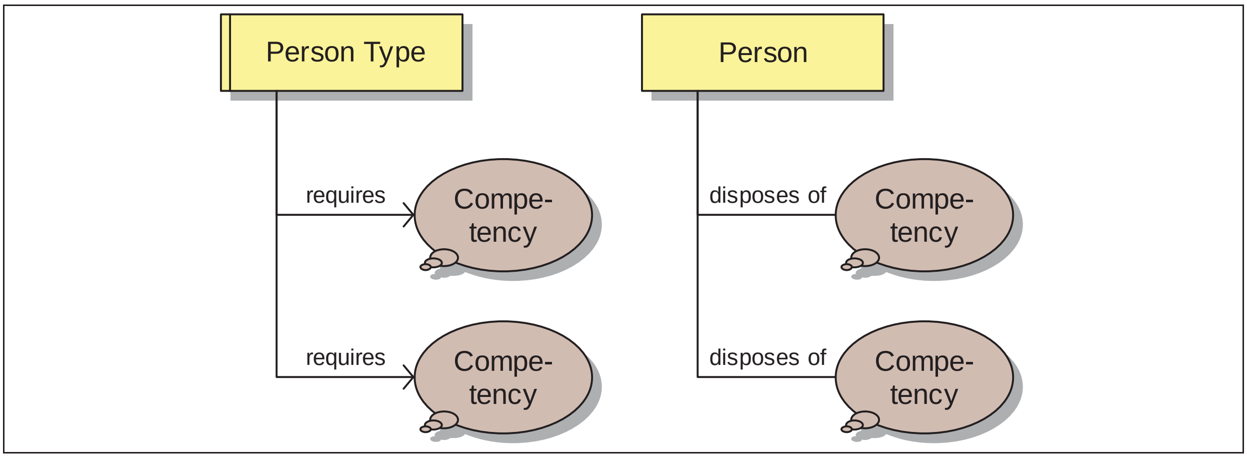

Figure 3: CompetencyMap

competency profile instantiation specifies the levels of all subordinated competencies. In its maximum form a competency profile instantiation includes only competencies of the maximum level. The number of possible instantiations of a competency profile (in terms of competency levels) is exponential to the the number of proficiency levels and the number of competencies[2].

The competency object type, illustrated by a light brown thought bubble, can represent both a competency and a competency profile. The competency object type provides two attribute types for maintaining the proficiency levels: Degree of coverage and desired degree of coverage that allows to model competency levels.

Competency Structure Diagram models are used to describe the structure of a competency, i.e., its composition and internal relationships. In EPC diagrams only single competencies without detail will be shown; competency structure diagrams allow their detailed structure as a hierarchy of subcompetencies to be described. The main object type used in competency structure diagrams is the competency which can describe both a composite and an atomic competency. Competency objects can be brought into a nesting or specialising order by connecting them with connections of type encompasses or is generalisation of respectively.

Figure 2 shows a competency structure diagram with nested competencies.

Competency Map models are used to document where competencies are required (competency sinks) or provided (competency sources) in an organisation. They describe relations between organisational units and competencies. Consequently they contain competency objects as well as the organisational unit object types. In order to distinguish the provision and demand of competencies two connection types can be used:

- *requires*: Expresses that an organisational unit needs the connected competency in order to act effectively. With this connection type it is possible to model requirement profiles for a certain role, for example.
- *disposes of*: Expresses that an organisational unit provides the connected competency.

Competency objects do not contain information about proficiency levels for a particular organisational unit. Such information is maintained in the connections between competencies and organisational units. Both the requires and disposes of connection types provide the attribute types Degree of coverage and Quality of coverage for doing so.

Figure 3 shows a Competency Map model with a Person Type object defining competency requirements for a role and a Person object providing competencies.

3.3 Competency-oriented Process Modelling

In the ARIS methodology, process models are located in the so-called control view which links all the other views (organisation, data, function, product/service). Process models therefore describe the flow of activities as well as required resources and data in order to produce a product or service. Competency-enriched process modelling extends this approach by taking competencies into account. Competencies are provided by organisational units as described above and they are required for the execution of activities.

2. $|CP| = |L|^{|C|}$ with $|CP|$ number of possible instantiations, number of subordinate competencies, $|L|$ number of proficiency levels.

Specifying these relations within process models helps to locate where certain competencies are required in process execution and by whom they have to be provided. This is essential for process performance improvement in the context of the PLLC.

The basis for competency-enriched process models are Event-driven Process Chains (EPCs). Events are an essential part of EPCs, as the name suggests. An EPC starts and ends with at least one event object. Activities are defined by function objects. The end of a function is marked by an event which triggers the following function. This linkage of events and functions produces a chronological-logical sequence called a process chain. The logical interdependencies of possible branching points and loops can be expressed by means of logic operators (AND, OR, XOR), so-called rules. Events, functions, and rules define the control flow of an EPC. A detailed description of syntax and semantics of the control flow in EPCs can be found in [NüRu02]. The control flow forms the basic structure of an EPC. Information from other ARIS views are linked in by connecting objects from these views to objects of the control flow. With respect to competency-enriched process modelling human resources and competencies are the most significant ones.

Human resources, i.e., organisational units can be assigned to function objects by means of different connection types, e.g., carries out, contributes to, decides on, or must be informed about. Each of them has different semantics which also means that depending on how an organisational unit is involved in function execution, different competencies may be required.

The execution of functions by organisational units requires competencies. In order to express these relations competency objects can be added to EPCs and connected with functions and organisational units. The connection between organisational unit and competency expresses the same type of relation as in a Competency Map. That means either a provision or a requirement of the competency by or for the organisational unit. The EPC in Figure 4 is modelled on a type level. Therefore a Person Type object is connected with the competency by a connection of type requires. If the EPC were modelled on an instance level, a Person object and a connection of type disposes of could have been used.

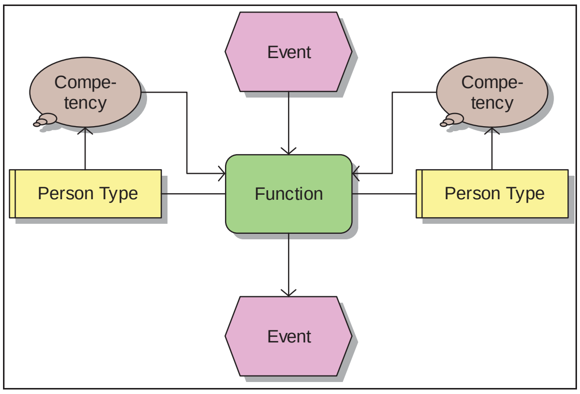

Figure 4: EPC with two Competency objects at one function

The connection between competency and function expresses that the attached competency is required for executing the function. The connection is of type is required for. Analogous to require and disposes of connection types, is required for connections provide the attributes Degree of coverage and Quality of coverage for specifying the required proficiency level.

The competency analysis concept introduced in PROLIX works with pairs of artefacts and competencies. An artefact can be, among other things, a function or an organisational unit. The gap analysis, for example, can work by comparing competencies connected to two different organisational units.

As the subsequent chapter will describe simulation is another analysis step besides the competency analysis which relies on business process models as an information source. For simulation both connections are relevant since a change of the proficiency level of a competency may have an impact on properties of the function, e.g., the processing time. And the proficiency level of an organisational unit is a property of the connection between competency and organisational unit as explained before.

Finally, the option to model both connections is necessary because it enables identifying which competency, required for the execution of a function, has to be provided by which organisational unit in case more than one organisational unit is connected with the function. This is important for business performance analysis and performance monitoring.

4 Competency-oriented Business Process Simulation

4.1 State-of-the-Art

Business Process Simulation is part of continuous process improvement (CPI) that aims for constant enhancement and alignment of business processes with internal and external business requirements [Sche99]. Business Process Analysis yields deficiencies that are to be overcome by to-be (future) process design. Those changes in process design must be enabled and implemented organisationally as well as technically before they can be executed, controlled and measured.

Process simulation is used when the performance of to-be processes is to be analyzed. Since redesigning business processes involves changes in people, processes and technology over time, the interactions of individuals with processes and technology result in an infinite number of scenarios and outcomes that are impossible to comprehend and evaluate without the help of a computer simulation model. [Tuma95] Thus, simulation helps bridging the gap between assessment of the existing and the design of the future. By introducing dynamic parameters of the process, like times, volumes, capacities and quality simulation fundamentally enhances process performance analysis. It provides a much better picture of bottlenecks, hand-over times and dynamic performance than a static analysis [AgRa+99].

Process simulation is an instrument to estimate performance for a given process definition with a specific combination of parameters. It provides the possibility to test alternative solutions in different scenarios. Whereas process modelling allows for qualitative assessment, process simulation permits quantitative measurements through virtual execution of a large number of process instances. Thus, simulation is not to be mistaken for optimisation as it does not provide an algorithm that calculates the optimal process solution. Moreover, one can gain insights into process characteristics by applying human intuition and experience. Playing with parameter variation helps identifying the sensitivity of the process model to performance ([NeRo+05], p. 431).

Reasons for using simulations instead of the real system are tractability, training purposes and the black box problem. Tractability means that it is too time-consuming or expensive to play with the real system to answer "what if" questions, indeed the real system may not even exist. "By tweaking decision variables in a model without the cost and risk of disrupting existing operations or building a new system, one can accurately predict, compare, or optimize the performance of the re-engineered process." [Tuma95]. The black box problem is concerned with the discovery of the workings of a poorly understood real system, e.g., national and world economies ([BrFo+87], p.3).

Common objectives of process simulation are ([NeRo+05], p. 437; [AgRa+99]):

- identification of syntactic and semantic defects and checks of correct process logic
- better comprehension of the process in general leading to valuable ideas for future process design
- ability to anticipate and to simulate any envisaged change in process design
- definition of throughput times and process costs
- assessment of different process structures
- graphical animated communication of process re-design
- training employees involved in the process
- support for resource planning by simulating alternative personnel staffing and assignment and analysing the effects on process performance

The starting points of process simulation are process models describing the sequence of events, activities and decisions leading to a certain outcome. For business process simulation to be useful, simulation-relevant attributes have to be maintained within the business process models. Such attributes are for example:

- processing times of each function,
- cost of each function,
- number of (human) resources involved in each function,
- junction rules including the activation probability of each branch and
- instantiation rules and frequency of start events.

Concerning the execution of the simulation itself, one distinguishes between animation and simulation. Whereas animation often runs only one process instance in single-step-mode, simulation runs a multitude of process instances to check for process performance over a longer period of time. The former allows the analyst to check the control logic step by step and to intervene when necessary. The latter is fully automated and generates the actual simulation results needed to analyze and optimize key performance indicators of the process. Interpreting the simulation results includes identifying KPIs and potential deficiencies of the process. This requires knowledge of average performance, minimum and maximum value as well as additional statistically relevant measures ([NeRo+05], p. 439).

4.2 Use Case

The performance of a process in execution not only depends upon the amount of resources but also upon the proficiency of people in competencies required for process execution. In order to improve performance of a process in execution it is therefore necessary to know what the ideal proficiency levels for the involved roles are. Such a to-be configuration can then be matched against as-is proficiency levels of people occupying the roles and makes it possible to derive training needs for the individuals. Simulation is used as a tool to find the to-be configuration.

The main use case for competency-oriented business process simulation is the refinement of competency requirements based on the estimated performance of process execution. However, competency-oriented process simulation can also be used for other purposes, e.g., staffing a process according to the competencies fitting best. Both use cases are described in the following paragraphs and serve as the basis for the requirements presented.

4.2.1 Process Simulation for Refining Competency Requirements

Based on a predefined objective (e.g. given by an objective function), several simulation experiments are run and the results are analyzed in order to improve the examined processes. Traditionally the analysis concerns the discovery of weak points, bottlenecks, unused or overworked resources, or other inefficiencies like media breaks or redundant tasks. In PROLIX the analysis also includes an evaluation of the competencies required to carry out tasks in the examined processes. Based on the analysis results the processes are improved by adapting the process structure and by changing resource assignments and capacities but also by specifying the optimal proficiency levels for competencies required and applied by roles involved in process execution.

Changing proficiency levels can affect time, cost and quality throughout process execution. In addition it may make it possible to change organisational configurations (e.g. a more skilled worker might perform additional production steps which formerly were done by additional personnel) or use different techniques requiring less process steps leading to a (further) adaptation of process structure.

4.2.2 Process Simulation for Optimal Staffing Decisions

Based on a predefined objective the objective is to find the best assignment of available personnel to activities in a process taking the different competencies of employees into account.

Such an assignment based on proficiency levels can help to improve performance in the short-term where it is not feasible to train the involved individuals. In order for the analysis to be carried out, the influence proficiency level changes have on factors affected by the respective competencies have to be defined and the proficiency levels of the involved employees have to be known which might not be the case due to privacy regulations.

4.3 Procedure Model

Before conducting the competency-oriented simulation a process can be analysed and improved with respect to general process inefficiencies like media breaks, redundant activities, etc. This can be done by running a conventional process simulation first. This step also helps to identify the bottlenecks the subsequent competency-driven simulation should focus upon.

4.3.1 Competency-enhanced Business Process Modelling

In a first step a business process model is created according to the competency-enriched process modelling methodology. This means modelling the control flow, the human resources involved in the process and the competency profiles required for task execution.

4.3.2 Competency-oriented Simulation Configuration

The simulation configuration is concerned with the determination of the performance and cost factors to be added to the process model in order to form a simulation model. For the factors depending on proficiency levels this means to find the value corresponding to a certain level.

Since the optimisation of a process through simulation is an iterative approach involving the experimentation with different value configurations, it can be helpful to establish a functional relationship between proficiency levels and factor values which can also be done in the simulation configuration phase.

4.3.3 Competency-oriented Process Simulation

Once the business process model is configured and the simulation scenario is set up, simulation can be carried out. The results of simulation are performance and cost indicators which can be used to evaluate the simulated (competency) configuration according to the objectives defined before. In case the results are not satisfying, the configuration is changed and another simulation run is conducted. If the results are satisfying, the competency configuration is used for further steps according to the objective of the evaluation, e.g., the determination of competency gaps and training requirements of involved personnel or the selection of suitable people for certain roles.

4.4 Prototypical Implementation

The competency-enhanced business process simulation procedure is supported by the integrated interaction of three software tools in PROLIX. Business

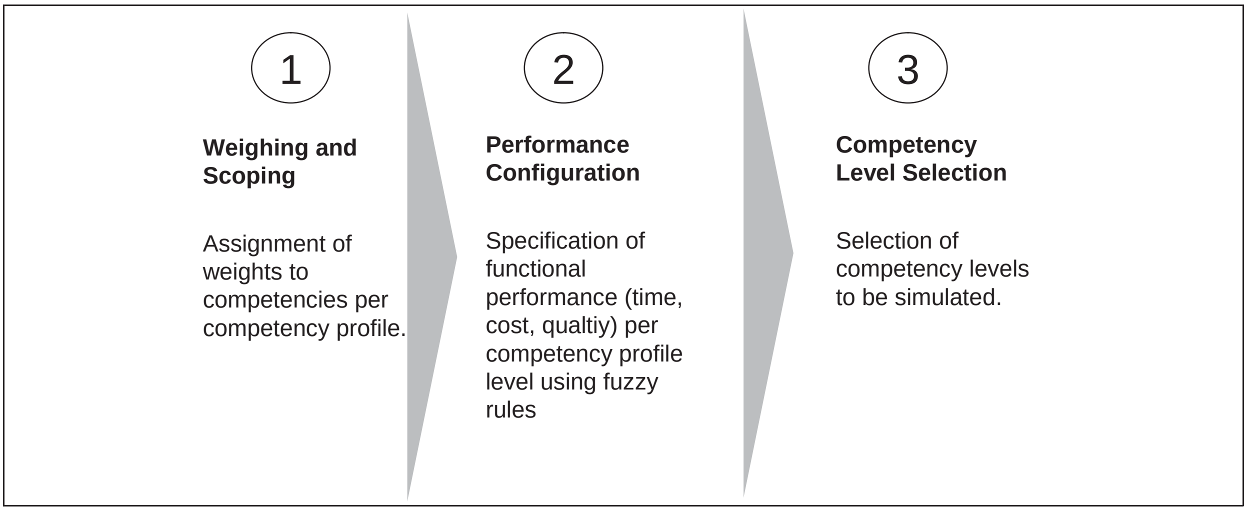

Figure 5: Three steps of Simulation Configuration

process modelling and simulation are done with the so-called Business Process Cockpit, a derivate of ARIS Business Architect and ARIS Business Simulator. For competency profile modelling and matching the Competency Analyzer, a competency and HR management system, is used.

The simulation configuration is supported by the so-called Simulation Configurator.

The configuration of the process model is a pre-processing step that includes competency-relevant performance data into the process simulation model. Since the Process Simulator processes performance attributes per function, the possible impact of competencies on the performance of a function must be translated into those performance attributes. Since this impact is likely to vary among different competency levels, ideally this translation must be done for each possible competency level. To encounter this complex challenge the simulation configuration is structured into three steps (Figure 5). First, scope and weights of competencies per competency profile are determined; secondly, all possibly needed performance data is specified on a functional level or by selecting a performance function; thirdly, competency levels are selected per competency profile, making up a specific competency configuration that is the basis for the first simulation.

4.4.1 Competency Weighing and Scoping

In order to reduce complexity and focus upon most critical competencies, this step allows for prioritizing competencies by weights.

Weighing and scoping comprises the following steps (Figure 6):

- For each competency profile derived from the imported business process model the corresponding competencies are requested from the CA and displayed in a tree hierarchy.
- For each competency profile, the HR analyst assigns weights to the competencies per competency profile (in the context of the function and the role). In particular, competencies can be weighted on a spectrum of 0-100% to determine their impact on the functional performance. Assigning 0% means to disregard this competency. Weights assigned must sum up to 100% within one competency profile. Thus, assigning 100% to one competency of a profile entails disregarding the others. The application controls that the weights are correct i.e. they sum up to 1.
- For matters of complexity reduction[3]:
  - the X most important competencies can be selected automatically (the value X can be manually defined in the options menu)
  - The HR analyst can select the Y most important competencies manually by check marking.[4]
  - The HR analyst can predefine a specific threshold Z: The competencies whose weights are below this threshold are not further taken into account.

3. This is necessary due to the exponential growth of the number of competency profile instantiations based on the number of competencies.
4. The same effect is achieved by assigning weights of 0 to those competencies that are not significant for function performance.

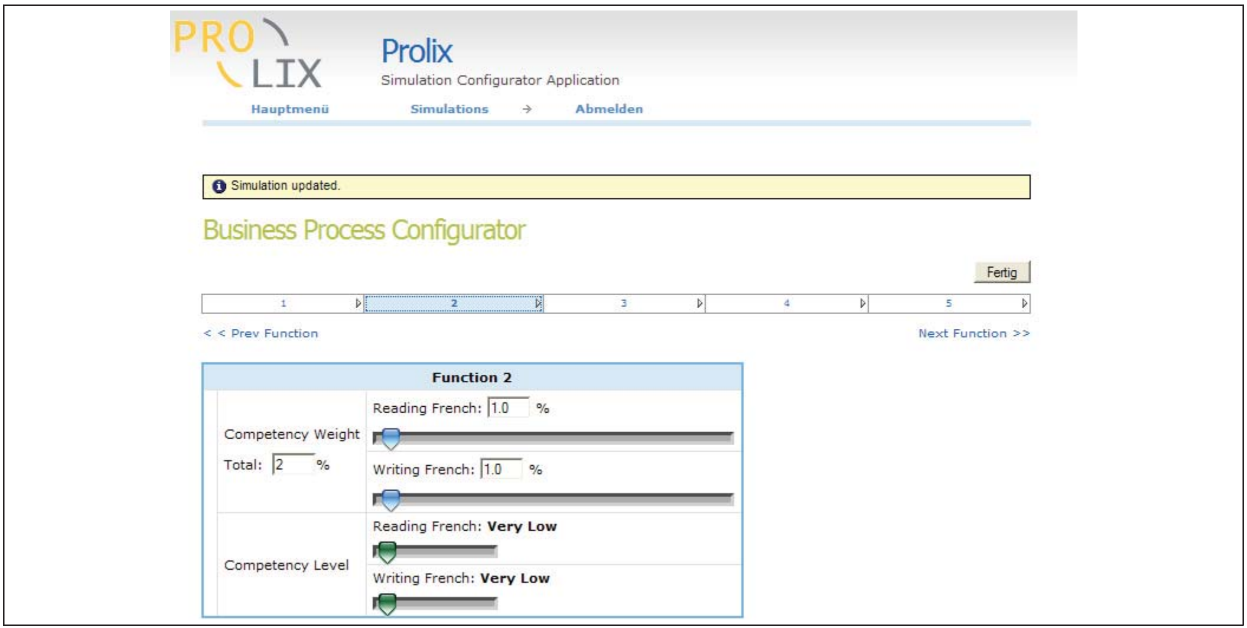

Figure 6: Screenshot of Weighing and Scoping Profiles

The weights of the reduced competency profile are recalculated automatically. The following steps consider only the reduced competency profile.

4.4.2 Performance Configuration

The Performance Configuration is the core of the simulation configuration. For this translation of competency impact to functional performance, the Simulation Configurator displays for each function and for each performance dimension a dialog box. Key performance indicators include, but are not limited to cost, time, and quality. In each dialog, each competency profile instantiations (set of competencies assigned to competency levels) is to be assigned to a performance figure, that is expected for the execution of the function given that the executing employee possesses competencies that correspond to this competency profile instantiation.

The challenge herein lies in the sheer amount of values that need to be specified. As outlined above, the number of possible competency profile instantiations for only one competency profile increases exponentially with the number of competencies and linearly with the number of competency levels ($|CP| = |L|^{|C|}$). Therefore, having the user enter all performance data manually appears hardly feasibly. It is difficult enough to judge the possible performance impact of one competency profile instantiation. Doing so for a very large number of different instantiations may overstrain the user's cognitive ability. Therefore, various ways of how the user is supported in this task have been explored. Figure 7 shows an approach that allows the user to define performance rule based on fuzzy logic.

4.4.3 Competency Level Selection

Once all values are specified for all possible competency profile instantiations, each of them can be simulated within the process.

- The application displays a tree of all (reduced) competency profiles and provides radio buttons to select levels for each competency.
- The user selects one target competency profile instantiation for each function that he considers most promising[5].

Swapping performance configuration and competency level selection would limit the tedious task of performance prediction to only those competency profile instantiations that are needed for the first simulation run. However, this approach would impede the continuing experiments with alternative competency parameters.

After the competency profiles are instantiated with competency levels to be simulated, the Simulation Configurator calculates the functional performance based on the previously specified performance values. The Simulation Configurator creates an XPDL-based business process model enhanced by

5.Based on the interrelationships entered for each function of the business process model, the configurator may highlight which configuration of a competency profile (=competency profile instantiation) appears to be most critical, i.e., promising most impact on the process performance. This recommendation is based on frequency and the control flow ("critical path functionality"). (this should be a functionality of ARIS!)

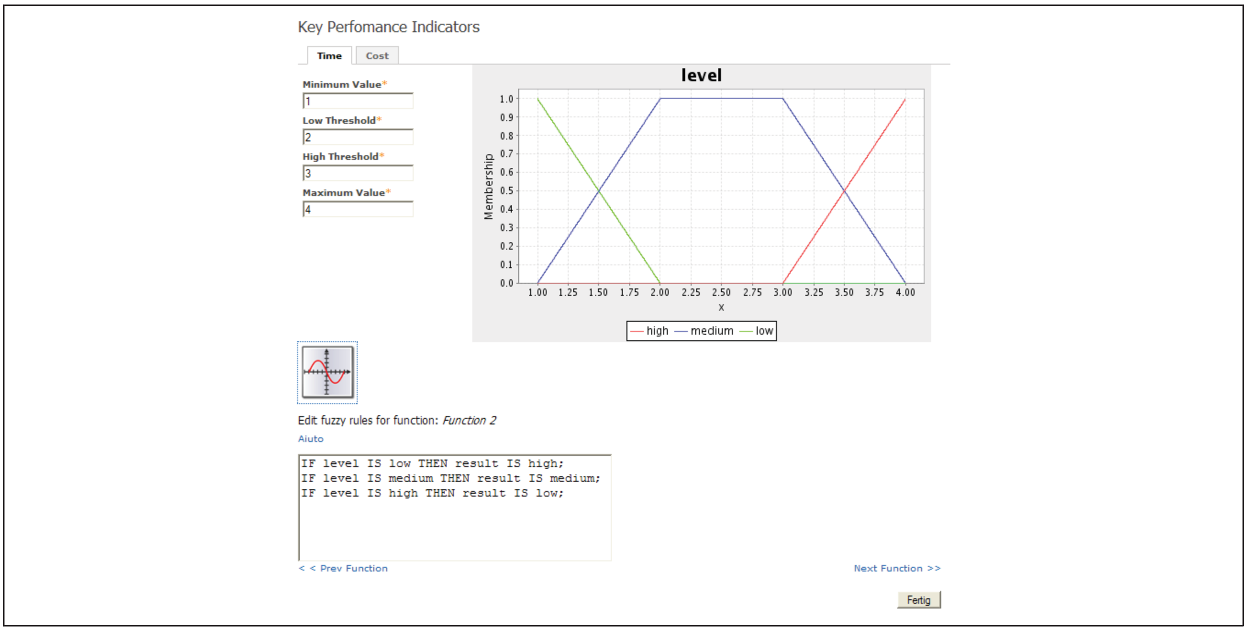

Figure 7: Screenshot of specifying performances predicted for competency profiles

simulation attributes for this specific set of competency profile instantiation (as chosen by the user). Those values are displayed per function and once accepted by the user, they are added to the XML process model as performance attributes. Those functional attributes are needed to run the simulation[6]. Before the simulation is started, the application must check whether the simulation process model is complete. If it is missing performance values, the application must ask the user for these. All input needed for simulation has been gained by translating competency levels into performance-relevant data per function in the previous step. The enhanced business process model is passed to the process simulator that runs the actual simulation (Figure 8).

With the process simulator process models can be simulated interactively or non-interactively. In interactive runs, model objects are animated on activation, with result attributes being displayed and constantly updated for each object. This is particularly useful for learning more about the runtime behaviour of a process. If only numerical results are required, animation can be deactivated to speed up the simulation run [IDS08].

The results delivered by the process simulator for evaluation purposes are presented in the form of tables and provide a range of information, including data on the various object types and process instances. For example, function statistics provide information, such as the number of function executions or wait times, while process statistics provide insights into the number of completed process instances or their throughput times ([IDS08]). The analysis of this data makes it possible to find modelling errors, inefficiencies, and weaknesses. It also enables the user to measure preferability of a competency configuration with respect to the optimisation objective.

6. The resulting competency profile instantiations have been assigned to performance figures on a functional level in the previous step, i.e., each function of the process can now be attributed with one performance figure.

5 Summary and Conclusion

The approach presented in this paper addresses the need to derive competency requirements from business processes in order to facilitate the alignment of employee competency profiles with business roles (staffing) as well as the effective closure of business-relevant competency gaps through tailored learning processes (business-driven personnel development). Therefore, we have introduced an extended process modelling methodology that allows for modelling competency requirements in business process models. In order to use this competency-oriented business process model for simulation purposes it needs to be enriched with performance projections based on alternative competency profiles instantiations. The simulation configurator supports the HR analyst providing this kind of performance data and generates a business process simulation model for a specific set of competency profile instantiations. The process simulator runs the simulation and delivers process performance results based on which the HR analyst decides to keep experimenting with them in

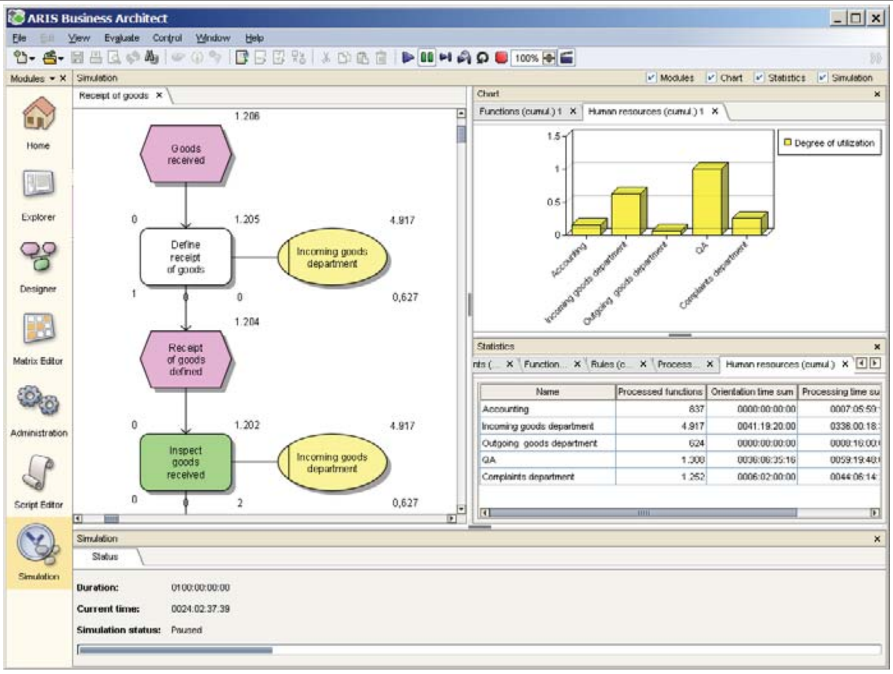

Figure 8: Standard Process Simulation

the Simulation Configurator or is satisfied and fixes the competency requirement specification for further staffing and training purposes.

Ideally, the performance data entered manually for each possible combination of competency profile instantiations and function would be gathered in the course of multiple iterations of the PROLIX learning lifecycle. The PROLIX performance monitoring component would be a possible source for this kind of data. Beyond the project, any kind of business activity monitoring tool could gather performance data for different competency distributions.[7] A machine-learning approach may then be able to derive rules that indicate how performance factors change with varying competency profiles. Thus, the HR analyst would have a solid rule base at hand instead of relying on his gut feeling. Thus, simulation configuration could be almost automated. All what remains to be done by the HR analyst is to play with different competency profile instantiations. Eventually, having rules for all possible combinations derived, an optimisation algorithm could be set up to identify those competency profile instantiations per role that achieve optimal business process performance.

The concept of simulation configuration is not limited to integrate the impact of competencies into business process simulation. An open research question is whether it could be applied to any other additional factors that are considered to influence process performance by any means. For example, service selection in a service-oriented architecture often depends on their quality-of-service and economic constraints. The identification of the optimal service may be supported by a similar kind of extended business process simulation. It would allow to simulate alternative services within a business processes before making the decision. Tackling this issue will be subject to our future analysis and research.

7. The ARIS plattform offers a Process Performance Manager (PPM) that is specifically designed to gather performance data along a business process across various transactional business systems (e.g. ERP systems, Office software).

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