COLLABORATIVE ASPECTS FOR INSTALLING E-BUSINESS IN A MAINTENANCE ENVIRONMENT

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Abstract. Business engineering process improvement is required because of the complexity of production and changing markets. Therefore, a multi-level-model is being developed by which it is possible to examine not only the enterprise level of the business processes, but also the person-oriented level. The philosophy was to bring together visions, tools and assistance as well as experienced personnel and different companies with different views and flexible organizations. This leads to a systematic, person-oriented distinction and integration of maintenance processes within collaborative structures, and an approach concerning the continuous improvement of the processes considering person-oriented abilities as cognitive constraints. The implicit knowledge of the executive persons is normally not integrated in existing business process analysis and therefore will be considered and integrated for the business engineering process improvement of maintenance activities.

Keywords: knowledge intensive processes, maintenance processes, modeling techniques, multilevel model, person orientation, virtual business.

1. Introduction

Business engineering process improvement focuses on supporting systematic business change. This change is mostly seen in integrating methods and software tools to analyze and redesign business processes. A large market was established in the last years to serve companies and institutions with both, methods and software tools. The tools serve different needs [1, p. 99–129], especially laid open when evaluating the software tools by "Ability to Execute" and "Completeness of Vision". Normally only one of the tools is used very often combined with ERP- (Enterprise Resource Planning) Systems.

However, within all of these software tools, the person is not in the centre of the methods and procedures. The elementary, methodological approaches of planning installed in the software tools seem to implement processes not taking into account e.g. personal abilities and their development. That is why methods were developed to correct the results of business engineering processes via psychological criteria [2]. But this approach is complicated not only because of the different terms used in the involved sciences.

A possibility for improving the business processes is offered through the development of new information and communication technologies like Internet by building cooperations like virtual communities, thus giving the chance to evaluate the given situation.

Very often companies want to realize this by outsourcing their maintenance processes. But this asks for visions, tools and assistance to bring together different companies in a special field. Therefore, a procedure is developed that supports a multilevel planning process using different tools and methods.

2. Steps of approach

The starting points for the evaluation were four companies interested in their cooperation to offer maintenance business on the market from one source. These companies represent the whole business chain of the maintenance process. This is a technical service sector requiring experienced personnel with special knowledge not easy to allocate in a single enterprise, thus giving room to virtual organizations.

The belief was that a virtual organization could be easily installed because all companies had the Internet presentation. The maintenance process was expected to be linked to the Internet platforms.

As the first step the business processes of the four companies were analyzed and evaluated separately. In the start-
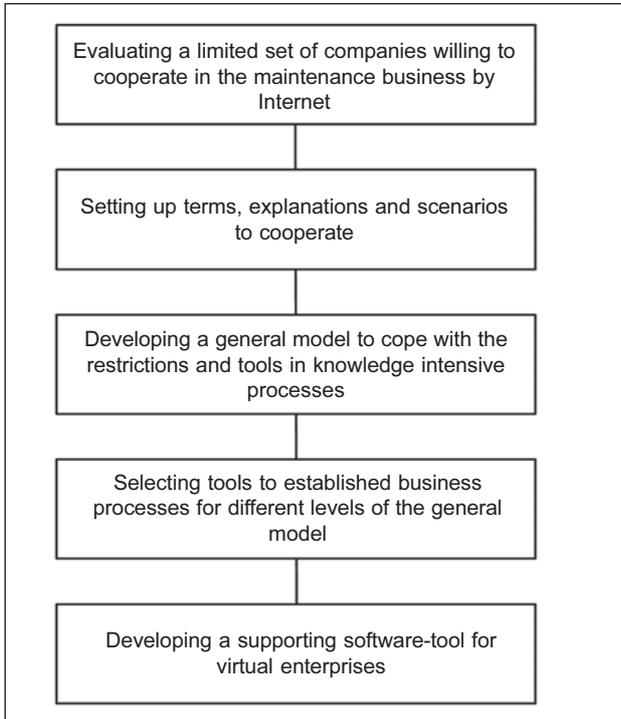

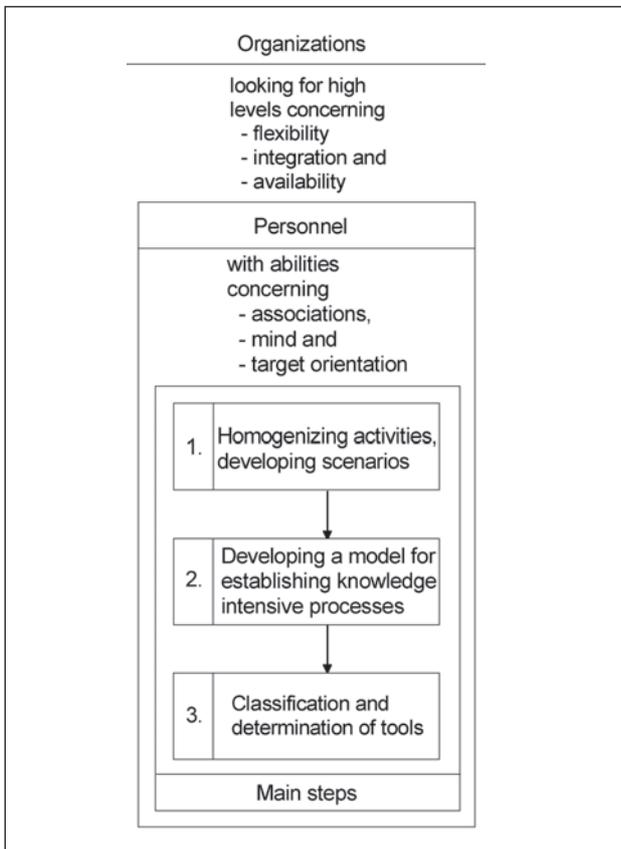**Fig. 1.** Steps of the exemplarily oriented approach to evaluate and support cooperative maintenance

Fig. 2. The main steps and considered restrictions concerning planning lay-out

ing phase the concepts of the participating companies, concerning the target groups in the existing Internet presentation, were examined. The investigation of these presentations showed great differences concerning the addressed target groups, and with one exception, the companies did no Internet-trading. Another point, that was emphasized, were the differences of the business process knowledge within the companies. Depending on the kind of position the employees had various mental models of these processes (Fig. 1).

The core idea of the approach was seen in the process itself. The starting points were the rough activities of the maintenance processes. The rough activities were projected in four scenarios.

The second step was to lay down the procedure for a model to establish knowledge intensive processes. By the model it should be overcome that the organization and the persons do not get lost in the large amount of information that can easily be handled by electronic information systems.

After having established the general outlines, tools had to be selected to establish business processes for different levels.

The process ended up in developing a software tool that could support maintenance processes within virtual enterprises.

3. Planning ideas of the model

Further activities depicted the processes. Special attention had to be paid to the interfaces between the companies on the one hand, and between the persons on the other hand. The description of the interfaces needs to be exact in virtual organizations, in order to avoid misunderstandings of the business documents, e.g. due to the missing eye to eye contact between the acting persons. It was the intention to construct an idea about how companies could divide or organize the tasks of maintenance processes together.

The starting points were the rough activities of the maintenance processes. Ground could be laid based on the German standard for maintenance processes [3]. This is seen as a first step to homogenize the imaginations and thus activities within and between the companies using very often specific terms out of a special cultural background in a company for a general task etc., thus giving room for a true discussion among companies about their strategic issues. The rough activities were projected in scenarios concerning warehouse monitoring, maintenance service and conditions of the plant [4].

The second main step (Fig. 2) is to lay down the procedure for a model to establish knowledge intensive processes. This is seen in a multi-level-model as shown in Fig. 3. The belief here is again two fold: on the one hand supporting persons with limited human short-term capacity for processing information [5, 6] and thereby supporting the de-

velopment of abilities of persons, and on the other hand supporting the idea of a more transparent organization that can achieve higher levels of flexibility and availability.

The third main step (Fig. 2) is to evaluate mainly tools that are on the market. The reason is that in to-day's business engineering analysis mostly only one special technique for presentation is used and recommended [7] especially supporting only information system's needs by producing a large amount of information. But techniques should also serve the needs of personnel. Therefore, different types of modelling techniques were under review, for example SADT (Structured Analysis and Design Technique, IDEF0 in USA), Petrinets, Entity Relationship Modelling ERM, and Event-Driven Process Chain Modelling (EPC) concerning the suitability for maintenance processes and its initiating.

Realizing the main steps, it has to be taken into consideration that especially qualified personnel has distinctive abilities concerning associations and target orientation, etc. concerning work activities (Fig. 2). Furthermore, it has to be cared for that the organizations (Fig. 2) can perform on high levels concerning flexibility, integration and availability [8].

4. Realizing the multi-level-model

The model in Fig. 3 is based on theoretical considerations, for example standards for the tasks, scenarios for cooperation and possibilities for the process description and on practical applications like real processes in the interested companies and their strategies.

The model is supposed to be adaptable concerning the functional partitioning and the processes of offering the chance of changing business partners and processes. It shows the potentials for the construction of the business processing as well as the reference edge for companies or people who are engaged in maintenance processes.

While carrying out the top-down modeling the first 2 levels were built with SADT. This is a method for the graphical description of complex structures realizing an overview of the whole process and thus making the data-flow transparent due to only up to five activities. It is meant to integrate the different views by supporting an idealistic approach on the first level taking no time and capacity restrictions concerning the process into account. By this a holistic view of the business process is being supported. Fig. 4 shows the SADT-structure of the second SADT-level, in which the segments of executing maintenance activities, for example inspection, maintenance, repair and weak point elimination are explained (Fig. 4). The data that are necessary for executing the activities are shown as well. Thereby, the depicted technique gets along with the limitation of short-term memory (7 ± 2 chunks) and addresses the larger capacity of the picture memory [6, 9].

The third level is meant to be a refinement of the first two levels as well as a person and task orientated consider-
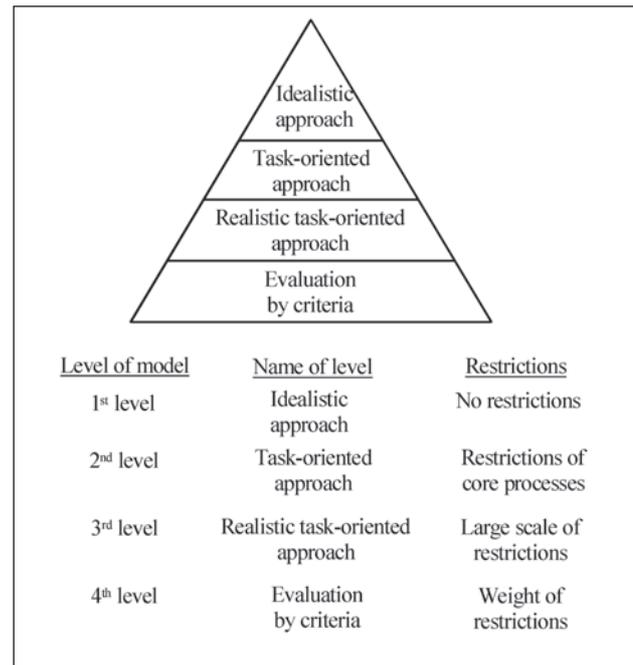

Fig. 3. Multi-level-model with top-down approach and back-loops (4th level) to be considered when establishing knowledge intensive processes

ation of the process. In this level activities, events, documents, it-systems (information-technology), data, the executive employees and the interface that presents the interaction between the employees should be described. Every process needs a defined start event for initiating the process and a defined end event that ends the process. On this level a large scale of restrictions has to be considered (Fig. 3).

This level can be realized with the extended Event-Driven Process Chain (eEPC) or the technique of Petrinets, a method that supports the connection of information processes in machines and plants. Fig. 5 shows a part of the third level from the process chain 'Equipment maintenance' realized with Petrinet-technique. If the arrow points towards an activity, the object is used for carrying it out. The other way round it originates through the activity. The activity flow is shown with full arrows. If there are options within the activity flow they are shown with shaded arrows. The employee is connected with a full arrow.

This level gives a detailed view concerning the work routine of a single associate. In addition to the scheduled linear work-flow optional processes can also be considered. These processes may happen due to obstacles of work. The model also supplies suggestions on behalf of an electronic knowledge base. The processes show the data or information necessary for the work-flow.

The maintenance process consists of many chains like the one presented in Fig. 5. These chains are differentiated depictions of the business process to establish reproducible processes even in one company.
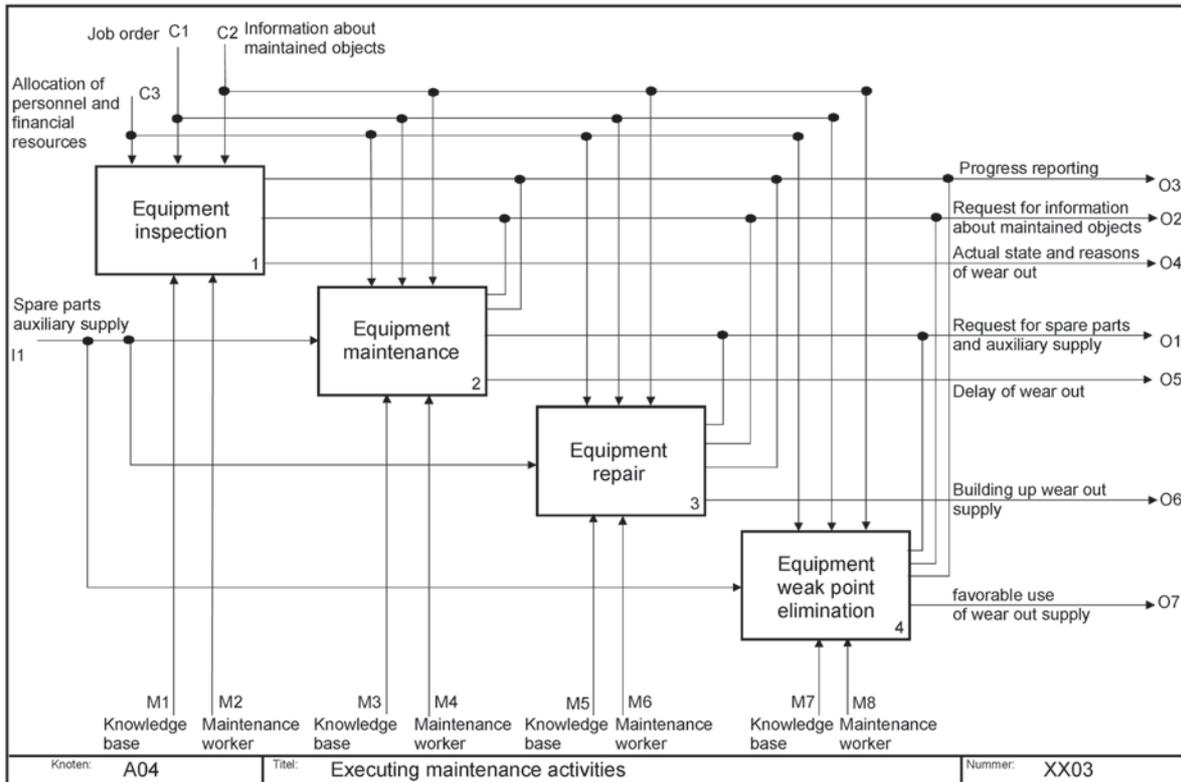
Fig. 4. SADT-structure for executing maintenance activities

The mixture of techniques supports the different views on processes by personnel, information systems and organization.

Altogether this modeling gives a differentiated and reproducible reconditioning of business processes with a knowledge of their own properties and the interfaces on enterprise and on personal level. This is seen as a basic requirement for building a virtual organization [10].

The fourth level integrates the evaluation and the improvement process by using two different approaches. One approach focuses on the implicit knowledge of the executive persons due to the special importance of the maintenance processing. This enhances the process chains of the third level with particular person-oriented elements. Fig. 5 gives an example for the integration of the elements, e.g. empirical knowledge and informal network which are identified as meaningful in executing the maintenance process. Concerning the human cognitive processing the process chains are action schemes which disburden the executive person by releasing capacities of the short-term memory for the anyhow knowledge intensive execution of the single activities within the maintenance process chain.

The second approach within the fourth level evaluates the processes involving their regulation level to derive cognizance concerning strain and stress on the executive persons. This was accomplished by the theory of activity regulation [9]. This approach results in a very detailed weighting of single activities. This was done with the point system

whereas the allocation of the points was related to distinguishing characteristics of Hacker's theory. Twelve points, the highest possible score indicates activities with great stress on cognitive skills of the executive person. The right column of Fig. 6 shows the activity 'realize distant maintenance'. Due to the systematic refinement of the maintenance process within the model this activity consists of five activities with different depictions of scores.

The required regulation level for the replacement and repairing depends strongly on the kind of damage. It can be very simple, e.g. if only a small electronic element has to be replaced.

But it can also be very complicated and time-consuming, requiring handicraft skills, knowledge and methodical procedures, e.g. for a greater mechanical defect. In the first case the allocation for all distinguishing characteristics can be realized by the automated regulation level of the human acting and in the second case by the intellectual.

The aim of these procedures is the development of tools which deliver concentrated assistance for critical activities, to find out the adequate qualified maintenance worker or to look, e.g. for activities useful to qualify workers and thus install dynamic processes. For such activities the selected building of software-tools and knowledge-bases is interesting.

Because activities relying on the intellectual activity regulation level can induce high strain on the person, esp. when several of the activities are going to be accomplished,
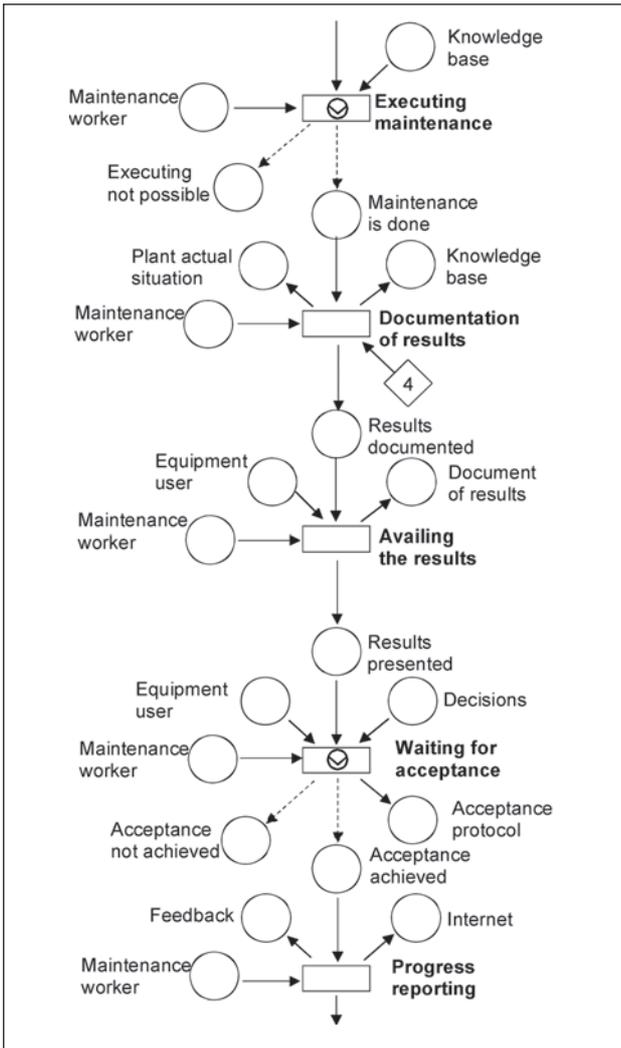
Fig. 5. Part of the maintenance process chain

(◇ connecting point and ⬡ logical connection)

they have to be structured and reduced. This leads to the development of a software-tool, the so-called work-flow-tool, which automates the information-flow between the activities by transferring documents and information from one person to another at the abidance of the right sequence processing and point of time for differentiated maintenance activities [11]. That also includes the definition of decision and responsibility allocation. Every activity has its own support so that it is possible to include, e.g. checklists and to connect the electronic knowledge base in the form of documents (Fig. 7). It is now possible to supply the employees with the needed information preventing that the search will take too much time or will even be unsuccessful. This program is laid-out to incorporate the maintenance planner and controller.
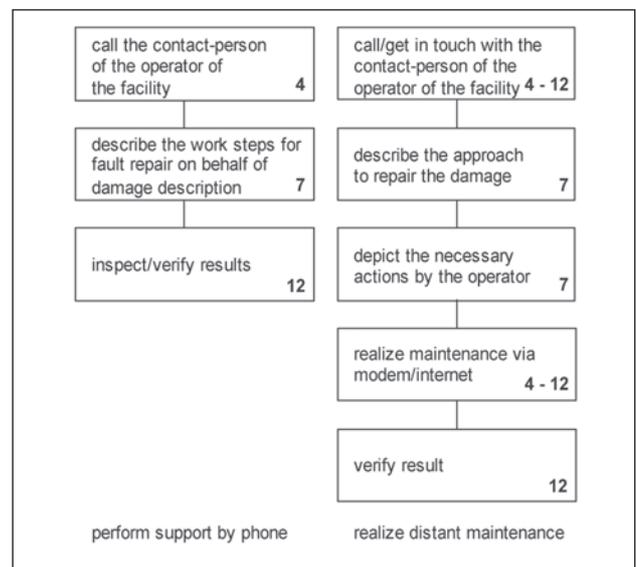

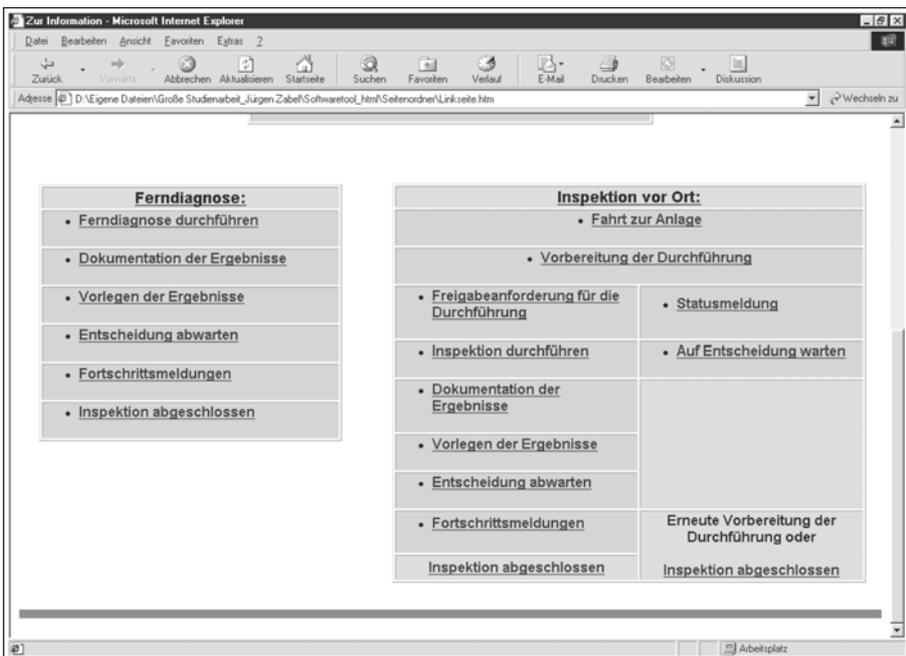**Fig. 6.** Weighting of the activities on the evaluation level (4th level of the model)

Fig. 7. Screenshot of software–tool for flow of information. Links to the activities of the structured maintenance process [11, p. 133]

5. Conclusions

With this approach the lay-out of the knowledge intensive maintenance business processes can be structured and reduced, especially concerning activities with high regulation requirements. The approach establishes transparency for all participants harmonizing the notions about the processes and serves as an acting orientation. It follows the principle of the preventive human factor considering ergonomic cognitions already in the design phase [12]. It was shown that for holistic support of the business processes it is necessary to integrate implicit knowledge elements. These elements need person-oriented strategies for improving processes on the one hand, and support information systems and organizations on the other hand. Software is important and needful but not sufficient.

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ELEKTRONINIO VERSLO ĮDIEGIMO ASPEKTAI ĮMONĖS VEIKLOS VISAPUSIŠKO RĖMIMO KONTEKSTE

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Santrauka

Verslo inžinerijos procesų tobulėjimą lemia nuolat sudėtingėjantys gamybos procesai ir kintančios rinkos sąlygos. Straipsnyje pristatomas daugiasluoksnis modelis, leidžiantis išnagrinėti veiklą ne tik įmonės, bet ir darbuotojo lygiu. Autoriai siekia integruoti įvairių įmonių patirtį, pasirinkdami tam tikrus aspektus bei tuo pačiu metu pripažindami, kad asmeniniai darbuotojų sugebėjimai tam tikrai atvejais tampa veiklą ribojančiu veiksniu. Straipsnyje taip pat akcentuojama, kad kiekybiškai neišmatuojama darbuotojų kompetencija neatsispindi įmonės veiklos analizėje, tačiau veikia elektroninio verslo diegimo tvaraus verslo kūrimo bei palaikymo procesus.

Reikšminiai žodžiai: žinioms imlūs procesai, veiklos rėmimas, modeliavimo būdai, daugiasluoksnis modelis, elektroninis verslas.

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