Analysis of information resource life cycle

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Abstract. The main purpose of this work is to propose an approach to the analysis of the life cycle of an information resource based on the analysis of real historical data about the resource. To achieve it, several problems are solved – collection of baseline historical data, in the format of event log identify important parameters and patterns in the life cycle status, and making recommendations to improve work with information resource. As an object of research, the article considers the life cycle of service as part of the information process. Service is a reaction of the company’s service Department to the incidents that occur, the consequences of which must be eliminated in a minimum period of time. Process Mining methodology and ProM software were used as the main analysis tools. For the life cycle analysis the additional module Inductive visual miner was applied, which allowed to identify typical chains of life cycle variants, and also to analyze the load of life cycle participants. The analysis showed bottlenecks in the life cycle, "weak links" among the performers, allowed to formulate proposals for improving the life cycle.

1. Introduction

A preventative maintenance strategy is effectively and fully implemented if the staff has the knowledge, skills and time necessary to carry out the relevant activities.

In the modern world, one of the urgent tasks of the development of the IT industry is the continuous use of various information resources (IR). This trend contributes to the acceleration of the growth of intellectual potential. Accordingly, there is a need to optimize information resources in order to make them more accessible, as well as to reduce the cost of time and money for their use, to make it easier. The task of the IT industry process is to provide at the right time and in a cost-effective form the necessary capacities for processing and storing various types of information resources, providing an appropriate balance of capacities in the IT organization.

It can be achieved by classifying information resources and taking into account their life cycle. To perform the tasks of the information management process requires a close relationship with business processes and IT strategy is required.

In recent years, work has been carried out that solved the issues of effective use of IR in optimizing the activities of organizations. For example: "life cycle management of educational information resources" [1], “Organizational Structure Optimization with the questions- Criteria Hierarchy ”[2] and "Evolution of the BPM Lifecycle " [3].

In the article Lifecycle-Based Process Performance Analysis [4], Wil van der Aalst and Bart Hompes describe and formalize life-cycle models and explain how events relate to life-cycle transitions, and also consider a structural approach for calculating and monitoring process performance according to real these events in the ProM tool.
In the considered works the actual problems connected with increase of efficiency of search, transfer and the analysis of information are solved. The task of optimizing its structure allowed to reduce the current costs associated with the maintenance of information resources.

The review of well-known works showed that the life cycle of information resources in the IT industry is not sufficiently connected with business processes and IT strategy. Based on data analysis, it is necessary to determine the causes of the vulnerability and solve the problems associated with the storage and processing of documents in the enterprise. It is proposed to track the movement of each resource to apply intelligent process analysis (Process Mining), which processes the "real" data – data obtained in real time by the system itself, recorded in the event log.

2. Methods
In the general structure of the process classification (Process Classification Framework) [5] developed by the (American Productivity & Quality Center), the following business processes for managing IR are identified:

1. To plan information resource management:
   - To define requirements based on business strategies.
   - To determine the architecture of enterprise systems.
   - To plan and predict information technology and methodologies.
   - To set the data standards of the enterprise.
   - To establish quality standards and control.

2. To develop and deploy enterprise support systems:
   - To assess specific needs.
   - To choose information technology.
   - To identify the life cycles of data.
   - To develop a support system of the enterprise.
   - To test, evaluate and deploy system security and control.

3. To implement system security and control:
   - To establish system security strategies and security levels.
   - To test, evaluate and deploy system security and control.

4. To manage data storage and retrieval:
   - To install databases.
   - To collect and organize information.
   - To keep information.
   - To change and update information.
   - To carry out the ability to search for information.
   - To destroy information.

5. To manage hardware and network operations:
   - To control the centralized equipment.
   - To manage distributed equipment.
   - To manage network operations.
6. To manage information services:

- To manage libraries and information centers.
- To manage the documentation and recording of business data.

7. To provide distributed access to information and communications:

- To manage external communication systems.
- To manage internal communication systems.
- To prepare and distribute publications.

8. Evaluate and audit the quality of information.

Based on the classification of business processes, an information resource during its existence passes the following stages of the life cycle (LC):

- collection of information, the creation of research;
- storage;
- processing (streamlining, searching, changing and updating);
- archiving;
- destruction.

Process Mining technology is an approach to the analysis of business processes based on modern tools in the collection and processing of data obtained directly from information systems [6]. The analysis is based on a complete array of data on all actions performed within the process. Using this method, the following results can be obtained:

- to see detailed information about each event, find the participants in the process that led to the deterioration of the values of a particular indicator;
- reduction of risks associated with existing services, as effective resource management and constant monitoring of equipment performance are carried out;
- reduction of risks associated with new services, since as a result of determining the configuration of technical means for the application (application sizing), the influence of new applications on existing systems is known. The same applies to modified services;
- reducing the threat of disruption of business processes due to close interaction with the change management process in determining the impact of changes on the capacity of IT and telecommunications facilities and preventing emergency changes;
- making more accurate forecasts with the accumulation of information by the information resources management process, which will allow faster response to customer requests;
- the growth of rationality due to the early achievement of the balance of supply and demand;
- to control of management or even cost reduction associated with the capacity of funds, due to their more rational using.

Process Mining technology allows you to adequately display the process of facts of data movement in the enterprise, therefore, to obtain a visual diagram of the life cycle of each resource and compare it with the current scheme. The Explore event log add-on provides a visual filtering method for event logs that makes process analysis tasks more feasible and traceable.

“Inductive visual miner”, based on the analysis of the event log, automatically restores the structure of the process model, then compares this model with the event log and visualizes a number of possible process improvements aimed at optimizing performance indicators, reducing the length of queues and accelerating their processing [7].
3. Results
In order to see the real history of transitions and processing of an information resource, we apply Process Mining technology to data on the performance of a service extracted from an automated service management system. A service is a description of an incident, as a result of which the cause of the current incident is eliminated and measures to prevent this incident in the future are developed. Table 1 shows the structure of the service data.

Table 1. The structure of the service.

| Service Number | Contractor | Date and time | Status |
|----------------|------------|---------------|--------|
| 10011          | User82     | 07.03.2019 10:42 | measure |
| 10011          | User82     | 07.03.2019 10:42 | measure |
| 10026          | User59     | 07.03.2019 10:58 | analysis |
| 10026          | User59     | 07.03.2019 10:58 | measure |
| 10026          | User59     | 07.03.2019 10:58 | close |
| 10028          | User49     | 07.03.2019 11:25 | open |
| 9896           | User62     | 07.03.2019 12:23 | comment |

A service can have the following states: “open”, “measure”, “analysis”, “comment”, “close”. When creating a service, an executor is assigned, and the status is set to "open". During the trial, the executor fixes the problem and a new corresponding state is added for each such step. After the proceedings are completed, each service receives a "close" status.

The process analysis was performed using the ProM system. As a result of the analysis were the duration of each service, the number of performers and States. In the future, these data can be used to trace the patterns in the work of each contractor and develop measures to improve the performance of services.

The main task when using the ProM program is to analyze each process. The "Log Summary" function allows you to get full statistics on all data loaded into the system. The total number of services in the entire history of the process was 3448 PCs.

As a result of the "Time Based Log Filter" function, an event log view was obtained that displays the dynamics of the duration of each service by date during the date range examined in the event log.

Figure 1. Trace Option.
In order to track the dynamics of the work and to identify the cause of the long-term performance of services, it was necessary to perform a detailed analysis of the results obtained. In particular, the resulting graph (figure 1) shows that in a number of cases, additional refinements take up more than half of the total execution time. This increases the workload of workers with unproductive activities and reduces performance.

After loading the data from table 1 in the number of records equal to 17438, the function “Explore event log” was executed. Figure 1 shows the results of the state dynamics and the actors involved in each process.

The aim of the study was to find out the number of performers involved in each work, as well as to find out the reasons for the high duration of the service. Applying filtering, data were obtained on the services with the longest execution period - №10017 and №10018. The results are shown in figures 2 and 3.

The obtained charts made it possible to identify the performers for each of the long-term services: No. 10018 (User 73; User 113; User 69; User 66), No. 10017 (User 62; User 49; User 40; User 85).

Function "State chart Workbench" allowed to analyze in detail the precedents No. 10017 and No. 10018. Figure 4 shows the results obtained for this sample, and table 2 contains data on the number of services performed for each of the performers.
Figure 4. Working condition analysis.

Table 2. Number of services performed for performers.

| Service Number | Contractor | Condition | Quantity |
|----------------|------------|-----------|----------|
| 10018          | User 73    | open      | 200      |
| 10018          | User 73    | measure   | 68       |
| 10018          | User 73    | close     | 61       |
| 10018          | User 73    | comment   | 52       |
| 10018          | User 113   | measure   | 877      |
| 10018          | User 113   | analysis  | 547      |
| 10018          | User 113   | comment   | 176      |
| 10018          | User 69    | comment   | 181      |
| 10018          | User 69    | measure   | 81       |
| 10018          | User 69    | analysis  | 89       |
| 10018          | User 69    | close     | 119      |
| 10018          | User 66    | measure   | 298      |
| 10018          | User 66    | analysis  | 109      |
| 10018          | User 66    | comment   | 211      |
| 10018          | User 66    | close     | 307      |
| 10017          | User 62    | open      | 290      |
| 10017          | User 62    | comment   | 128      |
| 10017          | User 62    | analysis  | 48       |
| 10017          | User 62    | measure   | 87       |
| 10017          | User 62    | close     | 86       |
| 10017          | User 40    | open      | 420      |
| 10017          | User 40    | comment   | 124      |
| 10017          | User 40    | measure   | 189      |
| 10017          | User 40    | analysis  | 65       |
| 10017          | User 40    | analysis  | 107      |
| 10017          | User 40    | close     | 125      |
| 10017          | User 40    | comment   | 130      |
| 10017          | User 40    | measure   | 125      |
| 10017          | User 85    | open      | 310      |
| 10017          | User 85    | comment   | 42       |
At the next stage, using the optional module “Inductive visual miner” from the event log, a service life cycle model was built. The result is shown in Figures 5 and 6.

Figure 5. Service Life Cycle Model Based on Event Log.

Figure 6. Service lifecycle model specific to a given user.

The analysis of the graphs showed the workload of the performers (User62 and User66 90% loaded) when opening the service. The analysis of the process using the ProM system of Process Mining algorithms suggests it at this stage, the scope of work is not completely clear to the executives, the composition of operations, which leads to an overload of the executor at the beginning of the service life cycle with additional clarifications and approvals.

4. Discussion
The results of the Process Mining application to the event logs of service provision allow us to say that the problem of delay of some services on one contractor has been identified. To solve this problem, it is
necessary to consider the construction of the service life cycle in such a way that the services are not delayed by the performers who may be absent for any reason. Without the use of ProM, these results could not be obtained.

To relieve the workload of the contractor when opening a service and increase productivity, the following solution is proposed. The “open” status must be broken down into several stages in order to prescribe the amount necessary for further implementation. By adding the statuses "open_urgently", "open_normal" and "open_long", it is possible to further track at what stage the contractor is most loaded and transfer this work to another employee who will work to another employee who will be engaged in the distribution of services to co-executors. This reception will ensure the guaranteed implementation of the planned indicators for the number of processed service requests.

5. Conclusions

In this article, we have considered only part of the functionality of the software tool for the analysis of ProM processes on the example of real data of a functioning enterprise. After processing the input information, the results are obtained, allowing to consider in detail the interaction of the contractor with each service, to form proposals to improve the provision of services-reducing the waiting time for customers and reducing the time spent by employees on its implementation. The proposed improvements consist in the introduction of additional stages in the service life cycle and the corresponding statuses in the information system. With the accumulation of data on these statuses, it will be possible to analyze the movement of these statuses, as well as the entire period and compare it with the original result obtained. After data collection, it will be possible to confirm whether the use of additional statuses has allowed to unload the work of performers and reduce the waiting time for service for customers.

Continuous improvement of the process requires the study of data on the history of events in the dynamics and continuous updating of the obtained models. Application of methods and algorithms of Process Mining and ProM system with plug-in software modules allows to solve this problem. Thus, the proposed solution is an effective tool for studying the process, identifying shortcomings and problems and forming proposals for improving the life cycle of the service and tools for managing this service.

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