Improvement of the Process "Rendering the First Medical Aid" Based on the Use of the Hospital Information System Possibilities

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Abstract

Increasing competition in the medical services market necessitates improving the quality of services provided. The use of modern IT technologies and a process approach to management helps to increase the competitiveness of a medical organization through process automation. This study describes the results of improving the ambulance process through the use of the existing medical information system. To justify the effectiveness of the proposed "as it should be" model of the ambulance process, the simulation method and functional-cost analysis were used, which allowed us to assess the impact of the proposed changes on reducing the duration of ambulance waiting time.

Keywords: Business process reengineering, hospital information system, digital technologies6 increasing the effectiveness.

Introduction

Due to the constantly growing demands on quality, service, flexibility and low cost of medical services, improving the efficiency of enterprise management is very important for maintenance and growth of competitiveness of the organization. Process approach to business management according to which activity of the enterprise is considered as a set of processes can be used for these purposes [1-3]. Process approach is applicable to the enterprises of the medical industry as the medical organization can be considered as a production system because it provides according to the established rules the final product – medical services [4,5].

Using a process approach to medical management can lead to a sustainable increase in the efficiency of a medical organization, while the question remains which methodology to choose for improving the processes in a particular case [6-8].

Improvement of processes of the medical organization is inseparably linked with using of modern IT technologies [9]. For medicine, a comprehensive industry solution is the Hospital Information System (HIS). Hospital information systems are systems for the collection, processing, storage and transmission of information designed to automate the activities of medical institutions.

The main objective of introducing HIS in a medical organization is to automate the processes of core activity by reducing the time that doctors spend on filling out paper based patient records [10,11].

The use of HIS provides great potential for medical organizations, subject to the full use of the available functions [12]. Otherwise, the effect of HIS implementation, as in the case with any other information systems, may not meet the expectations of the customer[13,14].

When reengineering business processes, an important issue is which method to use for assessing the effectiveness of the new TO-BE model of process system compared to AS-IS model [15,16]. At the same time, a significant part of research related to business process reengineering in medical organizations focuses only on a qualitative assessment of the business process reengineering results,

which makes it difficult to assess the actual effectiveness of the research results obtained by quantitative indicators [17,18].

The purpose of this study is to describe the "Rendering the first medical aid" process reengineering in a medical organization with a preliminary assessment of the effectiveness of the proposed TO-BE model. When providing ambulance services, it is vital to reduce the time between a call and its service. Therefore, the main goal of reengineering in this case is to reduce the average duration of an instance of the "Rendering the first medical aid" process.

Business process reengineering is associated with risks, therefore, before introducing a TO-BE model, it is necessary to assess whether it will really be more effective than the previous one [19].

The main goal of reengineering the "Rendering the first medical aid" process is to reduce the average duration of process instances while maintaining the quality level of the service provided, therefore, to assess the effect of reengineering in this case, the main indicator is the average duration of the ambulance service [20].

Methods

To improve the quality of the ambulance services, the process approach to the management of the medical organization was applied.

Researchers identify five main methods for achieving the goals of improving the business processes of organizations, listed below.

- 1. The technique of rapid decision analysis. When using this methodology, attention is focused on a specific process during a one- or two-day meeting of the process improvement group to determine ways to improve this process over the next 90 days. The decision of the group may be approved or rejected by the management of the organization.
- 2. Benchmarking. The method is based on a comparative analysis of the organization's business processes with the reference processes of organizations performing the same or similar processes, but better functioning. The purpose of benchmarking is to determine the reasons for the better functioning of the business processes of "reference" organizations and to prevent undesirable discrepancies with them in the organization that conducts the study.
- 3. Redesigning the process. This method focuses and efforts on improving the existing process. Redesigning is usually applied to those processes that are successfully working at the moment, but require correction due to changing requirements and the needs of the client or consumer.
- 4. Process Engineering. This method of designing business processes of newly created organizations or business processes of new types of business in existing organizations, taking into account best practices, is determined by the principle of optimality in process management.
- 5. Reengineering process. It is aimed at a radical change in the organization's internal business processes to achieve significant improvements in key performance indicators such as costs, quality, level of service and efficiency. It is used as a process management method in large companies, the main purpose of which is dynamic development based on the description of business processes [15].

To improve the process of "Rendering the first medical aid" is the most suitable method of reengineering. The main steps of company reengineering include:

- Choosing the strategic priorities of the company to formulate the goals of business reengineering and define the most important business processes of the company.
- Creating AS-IS model of company's business processes before the start of the changes.
- Analysis of AS-IS model and identification of bottlenecks in the company

- Development of a new structure of the company's business processes taking into account identified bottlenecks.
- The economic rationale for the transition to a new model of business processes.
- Development of supporting information systems. In this case, the required resources should be determined and, if necessary, a specialized information system is implemented.
- The transition of the company to new business processes, that is, the introduction of a new management system in practice [21, 22].

The strategic priority for the medical organization is to improve the quality of services provided. One of the most important indicators of the quality of a medical service is its timely delivery. Thus, the main goal of the "Rendering the first medical aid" process reengineering is to reduce the average duration of process instances while maintaining the quality level of the service.

To create a model of the "Rendering the first medical aid" process, it was decided to use the Cross-Functional Flowchart notation, since in this process it is important to display the process executors in order to visually assess their workload.

For the economic evaluation of the existing process, simulation modeling and functional-cost analysis of the AS-IS model was conducted.

To carry out the functional-cost analysis in the AS-IS model of the "Rendering the first medical aid" process, the following data was received from a medical organization: call frequency, time to complete each operation, and headcount. The simulation period was set to one week.

For the economic justification of process reengineering, simulation modeling and functional-cost analysis of TO-BE model with the same input data were also used.

Results and Discussion

The "First Aid" process consists of three stages: Reception of a call, Departure on a call, Execution of documentation.

The owner of the process is an Ambulance doctor.

Executors of the process are Paramedic on call reception, Ambulance paramedic, Ambulance doctor.

As a result of studying the "Reception of a call" stage, the following AS-IS model was constructed, shown in Figure 1.



Figure 1: Stage "Reception of a call " AS-IS

The Reception of a call phase begins with the receiving the patient call by Paramedic on call reception. Paramedic on call reception checks the patient for Electronic Medical Record (EMR) and starts it if there is no patient's EMR in the HIS. Then the Paramedic on call reception enters the HIS information about the call into the electronic schedule and in the paper based Journal of recording ambulance calls, and also transmits information about the call to Ambulance doctor. Ambulance paramedic gives Ambulance doctor a stack with potent substances. An Ambulance doctor makes an entry in the paper based Journal of accounting for the issuance and return of potent substances.

The stage "Departure on a Call" following the stage "Reception of a Call" is presented on figure 2.



Figure 2 : Stage "Departure on a call" AS-IS

At the "Departure on call" stage, upon arrival at the address, the Ambulance paramedic fills out the Paid Medical Services Agreement and the Informed Consent on paper. Ambulance doctor collects complaints and medical history, examines the patient and makes a diagnosis. Next, he fills in a paper based Emergency Call Record and prescribes treatment. If it is necessary to prescribe potent substances, the ambulance doctor prescribes potent substances and fills in the Potent substances prescription sheet. The doctor enters the information about prescribed treatment on the paper based Emergency Call Record. Further, the Ambulance doctor decides whether hospitalization is necessary and, together with the Ambulance paramedic, performs the hospitalization of the patient. Next, the Doctor fills in the Act on the provision of services.

The "Execution of documentation" stage of the process is presented in Figure 3.



Figure 3 : Stage "Execution of Documentation" AS-IS

At the "Documentation" stage, upon arrival at the medical organization, Ambulance Doctor enters the data in the computer based Emergency Call Record and fills in the Patient Visit Log. Ambulance paramedic returns stack with potent substances, Ambulance doctor makes changes to the Journal of accounting for the issuance and return of potent substances. The Paramedic on receiving calls fills in patients' EMRs and the Daily report on the work of the department.

According to the results of the functional-cost analysis of the existing AS-IS model, it turned out that the average duration of one process instance is 2 hours (Figure 4).

S	imulation processes	ulation processes Process statistics Time		resourse statistic	Material resourses statistics			cs Permanent re	Permanent resource statisticts			
Specification												
	Process	rocess				Avarage duration Avarage cost Total time waiting			iting for resources	•		
Þ	Rendering the first medical aid			691		2:03:10		246,98			0:20:00	

Figure 4: Statistics on processes of the AS-IS model

Apparently from statistics on subprocesses, the existing model has subprocesses that cannot start on time, because they are waiting for resources, that is, employees do not manage to carry out tasks right after their receipt.

During the analysis of process "Rendering the first medical aid" the following problems connected with the underutilization of HIS are revealed:

- 1. Interaction of staff of the medical organization happens without the use of HIS that conducts to excess time expenditure;
- 2. Part of documentation is not maintained in HIS that leads to duplication of information.

Consider these problems in more detail and provide possible solutions.

The problem of reducing the time between receiving a call and receiving information about it by an ambulance doctor is especially relevant in this business process, since it can be vital for patients to get an ambulance as soon as possible. At the "Reception of call" stage, the Paramedic on call

reception first enters information about receiving a call into the Electronic schedule, and then phones Ambulance doctor.

To reduce time between receipt of a patient call and the arrival, a solution is proposed to use the SMS notification function and the comment schedule that is already available in HIS but not used.

This will allow the Paramedic on call reception to enter the information received from the patient immediately into the electronic schedule. Then the Paramedic will not need to additionally transmit information to the Ambulance Doctor, as he will receive it immediately after Paramedic on call reception makes changes to the electronic schedule.

The next problem is that in addition to HIS, MS Word and MS Excel, as well as paper media, are also used for documenting in the medical organization. This leads to the fact that employees enter the same information in different reporting forms, that is, the medical organization irrationally uses the working time of employees.

For example, the Ambulance doctor fills out the paper based Emergency Call Record at the stage "Departure on a Call", and at the stage "Execution of Documentation" enters this information in MIS.

For the solution of this problem, it is offered to use a possibility of HIS to add and adjust the reporting forms. Transfer of documentation in HIS will allow to implement automatic filling of the documents created on the basis of other documents. It will significantly reduce the personnel time spent for maintaining documentation.

So, when transferring documents to MIS for most of the documents that are currently being maintained in MS Excel, MS Word or on paper, it will be possible to configure the automatic filling of fields from other documents that are also filled in this process.

Table 1 lists the documents filled in by the medical organization's employees in the "Rendering the first medical aid" process, indicating the original format of the document and the source documents for automatic completion.

Name of the document	Document format	Source document for automatic completion.				
Paid medical services agreement	Paper based	-				
Informed consent	Paper based	-				
Electronic schedule	HIS	-				
Journal of recording ambulance calls	Paper based	Electronic schedule, Electronic medical record				
Potent substances prescription sheet	Paper based	-				
Journal of accounting for the issuance and return of potent substances	Paper based	Potent substances prescription sheet				
Emergency call record	Paper based, HIS	Potent substances prescription sheet				
Electronic medical record (EMR)	HIS	Emergency call record, Potent substances prescription sheet				
Act on the provision of services	MS Word template	Emergency call record				
Patient visit log	MS Excel table	Emergency call record				
Daily report on the work of the department	MS Excel table	Patient visit log				

Table 1: Documents used in the process

Taking into account all offered changes TO-BE model of "Rendering the first medical aid" process is developed.

The chart of the stage "Reception of a Call" is presented to the TO-BE model on figure 5.



Figure 5: Stage "Reception of a Call" TO-BE

The stage "Reception of a Call" begins with the receiving the patient call by Paramedic on call reception. Paramedic on call reception checks the patient for EMR and starts it if there is no patient's EMR in the HIS. Further the Paramedic call reception enters the HIS information about the call into the electronic schedule. The information from the electronic schedule is automatically entered in the Journal of recording ambulance calls. Paramedic on call reception checks and complements the Journal of recording ambulance calls with missing information. The Ambulance paramedic reports to Ambulance doctor stack with potent substances. An Ambulance doctor makes an entry in the computer-based Journal of accounting for the issuance and return of potent substances.

Differences from the AS-IS model: the operation "Transmission of information about the call to Ambulance doctor" is excluded from the model as in the offered TO-BE model Ambulance doctor obtains the information on the call through the notification in HIS right after the Paramedic puts it in the electronic schedule. All documents are stored and available for changing in HIS.

The chart of the stage "Departure on a Call" of TO-BE model is presented on figure 6.



Figure 6 : the stage "Departure on a Call" TO-BE

At the stage "Departure on a Call" on arrival to the address Ambulance paramedic fills in the Paid Medical Services Agreement and the Informed consent on papers. Ambulance doctor makes collecting complaints and the anamnesis, survey of the patient and installation of the diagnosis. Further Ambulance doctor fills out the Emergency call record in HIS and appoints treatment. In need of prescribing of potent substances the he appoints strong substances and fills the Journal of accounting for the issuance and return of potent substances in HIS. The doctor enters information on the appointed treatment in the Emergency call record. Further Ambulance doctor defines whether patient needs hospitalization and together with the Ambulance paramedic performs hospitalization of the patient. Then Ambulance doctor checks whether the Act on the provision of services that is implemented as a reporting form in HIS was correctly filled.

Differences from AS-IS model: all documents that were on paper and in MS Word format are now implemented as linked forms in HIS, that is, when they are created, data such as patient information, call address, etc. is automatically filled. In this regard, the duration of the operations "Filling in the Emergency Call Record", "Filling in the potent substances prescription sheet" decreased.

The "Documentation" stage of the TO-BE model is shown in Figure 7.



Figure 7: Stage "Execution of documentation" TO-BE

At the "Execution of documentation" stage, upon arrival at the medical organization, the Ambulance paramedic returns the box with potent substances. Ambulance doctor makes changes to the Journal of the issuance and return of potent substances.

Differences from the AS-IS model: the Emergency call record in AS-IS model was first filled in on paper, then the data from there was transferred to HIS. Since in the proposed model at the "Departure on call" stage this document was filled immediately in HIS, the need for data duplication disappeared. The Patient visit log is implemented as a summary report in the HIS, that is, all data in this document is taken from other forms in HIS and is automatically filled out from the instances of the Emergency call record document.

According to the results of the functional-cost analysis of the existing TO-BE process, it turned out that the average duration of one process instance is 1 hour 40 minutes (Figure 8), subprocesses are not waiting for resources.

			6										
S	Simulation processes Process statistics Time		resourse statistic	Material resourses statistics			cs Permanent i	Permanent resource statisticts			Product statistics		
Specification													
	Process	Process				Avarage duration		Avarage cost		Total time waiting for resources			•
Þ	Rendering the first me	dical aid (TO-BE model	I)		695		1:40:13		176,76			0:00	:00

Figure 8: Statistics on processes of TO-BE model

Thus, the average duration of the Ambulance Assistance process was reduced by 20 minutes, which led to the absence of subprocesses that were waiting for available resources.

Conclusions

- 1. AS-IS model of the "Rendering the first medical aid" process allowed us to identify optimization bottlenecks associated with the underutilization of the capabilities of the existing HIS.
- 2. The functional-cost analysis of AS-IS model showed that the existing model has subprocesses that cannot start on time because they are waiting for resources, that is, employees do not manage to carry out tasks right after their receipt.
- 3. TO-BE model of the "Rendering the first medical aid" process has been developed.
- 4. As a justification for the effectiveness of the proposed model, simulation modeling and functional-cost analysis were carried out. They showed that the problem of resource expectation was solved in TO-BE model, and the average duration of the process instance was reduced by 20 minutes.

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