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**BUSINESS PROCESS MANAGEMENT IN MEDICAL  
ORGANIZATION**

**DIPLOMA THESIS**

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## **Declaration of Authorship**

The author hereby declares that she compiled this thesis and identification of mapping risks independently, using only the listed resources and literature.

Prague, 26 April 2016 ..... Signature

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## **Abstract**

The goal of this paper is to describe process management and a possibility of its implementation in the real medical organization. The first part is devoted to a description of the basic concepts, principles, definitions and procedures of process management, which form the paradigm. The second part deals with the application of process management in the real dental clinic and presents an analysis of the current state and its improvement recommendations, conceptual and process modeling, description of basic levels of medical information systems and recommends criteria for information system selection. Diagrams are created in programs PowerDesigner and Cacao.com are also included in this paper.

## **Keywords**

Process Management, Business Process Engineering, Process modelling, MMABP, reengineering, UML.

## **Abstrakt**

Cílem této diplomové práce je popis řízení procesů a možností jeho zavádění do reální medicínské organizace. První část je věnovaná popisu základních konceptů, principů, definic a postupů řízení procesů, které tvoří paradigma. Druhá část se zabývá aplikací procesního řízení v reálné dentální klinice a představuje analýzu současného stavu a jeho doporučenou modifikaci, konceptuální a procesní modelování, popis základních úrovní lékařského informačního systému a doporučená kritéria pro výběr vhodného informačního systému. Diagramy, znázorněné v dané diplomové práci jsou tvořené v programech PowerDesigner a Caccio.com.

## **Klíčová slova**

Procesní řízení, Business Process Engineering, Procesní modelování, MMABP, reengineering, UML

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## **Introduction**

Nowadays companies on Russian market have a lot of competitors and not enough of customers. To attract new customer and to hold present clients, companies should propose high quality products and services. Service delivery should be fast, high quality and low price. Companies should be flexible to continuously change and it can be achieved by process management implementation. The main reason to implement process management in organization is to be competitive in modern economy circumstances.

Organization from medical area has been chosen as a target company for process management implementation. That company is a dental clinic in Ufa, Russian Federation. Medical area is highly regulated and monitored by state. In addition to that, implementation of new processes or reengineering of present ones has to be done according to all norms and standards fixed by state with no violations.

Every medical organization should have an idea about its future development, no matter, if it is a private small clinic or a large state hospital. Therefore, it should have its strategy and goals. Goals are an essential requirement for medical organization's future.

## **Scope and goals of diploma thesis**

These thesis is intended to form basics for process engineering implementation in real medical organization. The goal is to describe all theoretical definitions, concepts and procedures, in order to select the most suitable methods for implementation in a real organization. The other goal is to implement MMABP in dental clinic in Russian Federation. Next objective focuses on analysis of the current state of this organization and on improvement recommendations. The recommendation will be described in conceptual and process models. Another outcome of that paper is a description of basic levels of medical information systems and criteria formulation for information system selection.

## **Structure of diploma thesis**

This diploma thesis consists of two main sectors – theoretical and practical part.

The first part of this paper is dedicated to a description of the basic concepts, principles, definitions and procedures of process management, which form the paradigm.



Second, practical part of that thesis deals with the application of process management in the real dental clinic in Russian Federation and presents an analysis of the current state and its improvement recommendations.

Conceptual and process modeling are represented through Class Diagram, State Chart, Global process diagram, BPMN and Data Flow Diagram. The last part of this section is dedicated to description of basic levels of medical information systems and recommends criteria for information system selection.

### **Approach to the solution**

The first step taken to address above listed goals was the research of scientific literature in order to gain theoretical insight in Process Engineering and Reengineering. Also it was necessary to discover medical area specifics especially in Russian Federation.

# **1 Process management and business processes**

## **1.1 Functional management**

For several hundred years until now functional approach was the main method used by all levels of management. This approach comes from classical economist Adams Smith's ideas. He found that manufacturing processes should be separated into constituent and simple parts. The organization is grouped by areas and those areas are divided into functional units. By labor division and decomposition of sophisticated tasks, less qualified employees may perform individual tasks.

Besides advantages like opportunity for employees to move up within their functional areas or knowledge sharing with other colleagues from the same field, functional structure has some disadvantages as well. One of them is a difficulty with working with other functional areas. There is often a situation that units are competing for resources or lack of other teams work understanding. As company grows bigger and functional areas are larger, functional units may become hard to manage. Thus their management methods, cultures and tools may vary.

Another disadvantage of functional approach is unclear responsibility for a certain process. Responsibility transfers from one manager to another person who is managing other functional team. It becomes very hard to find a responsible person if an issue occurs somewhere.

The last disadvantage is a communication barrier between functional areas and teams. Each team has its own manager, set of skills used in their day to day work and knowledge. Therefore, know-how and knowledge of individual teams often stays within that particular team.

Functional organizations are not process-friendly. They support fragmented task work. All departments and units are isolated and independent. Everything starting from structure of functional company and ending with its managerial style prevent employees from organizing their process work.

## 1.2 Process management

According to [ŘEPA, 2012], process is performed in order to achieve defined goals of a company. The goal of the main process is to satisfy needs of customer of market. In order to keep pace with challenges as emerging economy, changing trends, technology boom and with highly competitive environment in general, company has to be able to response to changes and act quickly. Improvement or change becomes a necessity within a market, were lack of customers is growing as well as number of competitors around. To be more successful not only occasional transformations should take place, but change itself should become a constant process. That is why ways to react on customer's needs are crucial to prosperity of companies and their existence on market.

In order to make company able to adapt to new challenges and opportunities, which come with economic and technological progress, it should be dynamically and flexibly managed. Emerging new technologies help to simplify or transform the way how processes currently run by increasing performance or modifying parts of processes [ŘEPA, 2012]. That's why process management can be a good tool for company's dynamic development allowing services, products and work improvement.

Due to the fact that needs and preferences of customer evolve and change frequently or even constantly, companies should react immediately and operate with high performance with high quality outputs. Another factors leading to that is customer's aspiration to have cheap product being delivered in short amount of time. Therefore, companies are forced to constantly evolve their business processes and abstain from keeping them static. Under conditions of changes in resources, methods and objectives the business process is considered to be dynamic and flexible.

According to [ŘEPA, 2012], process management is defined as organization management, there business processes plays a key role. Compared to functional management, in process management each business process has a strictly given responsible person. Process hierarchy is defined in process map defining responsibilities for all levels. Due to the fact that all activities are executed within defined process and do not overlap with other teams' work, responsibilities become more transparent and easy to track.

Nowadays, one of the most important values in organizations is their know-how. Know-how is understood as set of knowledge and information, which give company advantage, allowing fast reacting and performing their working activities more effectively [PROCHÁZKA, 2006]. Process management allows knowledge transfer from employees to processes description. That enables to store knowledge and information inside the company minimizing losses if employee decides to leave. Therefore, information is easy to manage, share and modify.

Storing information given from process explanation provides company with another advantage. This is a possibility to optimize processes. Optimization can be done by using software support or can be performed manually.

Process management allows companies to show transparency of their both external and internal processes. Organization can define and explain their relations with business partners like suppliers, customers, state institutions. Modeled processes may help partners make their relations work more effectively.

Each company defines their working activities in a way they find appropriate. One of methods to define working activities is by analyzing and mapping processes. Advantage of processes is unified and easy readable description. In case organization uses common way of explaining processes, it is possible that various units use not unified and different ways to define organization's behavior.

Process management allows better adapting to dynamical changes and improving its actions. In case organization follows previously defined and modeled processes, further activities change and response to external events is easier. That means that processes can be easily changed and implemented. On the assumption that organization has information system, which supports defined processes, all changes in processes should be mapped to information system and implemented. That gives company ability to implement minor changes immediately and major changes in shorter timeframe than in case if no process management is implemented.

### 1.3 Business Process

Several views can be applied to define a business process. There are situations, when one point of view defines entity as a process, while another does not, can happen. In order to avoid inconsistency between multiple views it is necessary to define, what exactly is considered to be a business process.

There are a lot of definitions of business process. According to [HAMMER, CHAMPY, 1993], business process is *“a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer. A business process has a goal and is affected by events occurring in external world or in other processes”*. According to [ŘEPA, 2007], a business process is *“generally understood as natural sequence of activities performed with intention of achieving given goal in objectively given conditions”*. Another author [DAVENPORT, 1993] defines business process as *“a structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus’s emphasis on what. A process is thus a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action. ... Taking a process approach implies adopting the customer’s point of view. Processes are the structure by which an organization does what is necessary to produce value for its customers”*. This point of view is supported by [ERIKSSON, PENKER, 2000], who say that a business process describes how work is done instead of describing products or services that are result of a process. By [BRUCKNER, 2012] business process is *“a group of related activities which as a whole bring a value to a customer (process)”*.

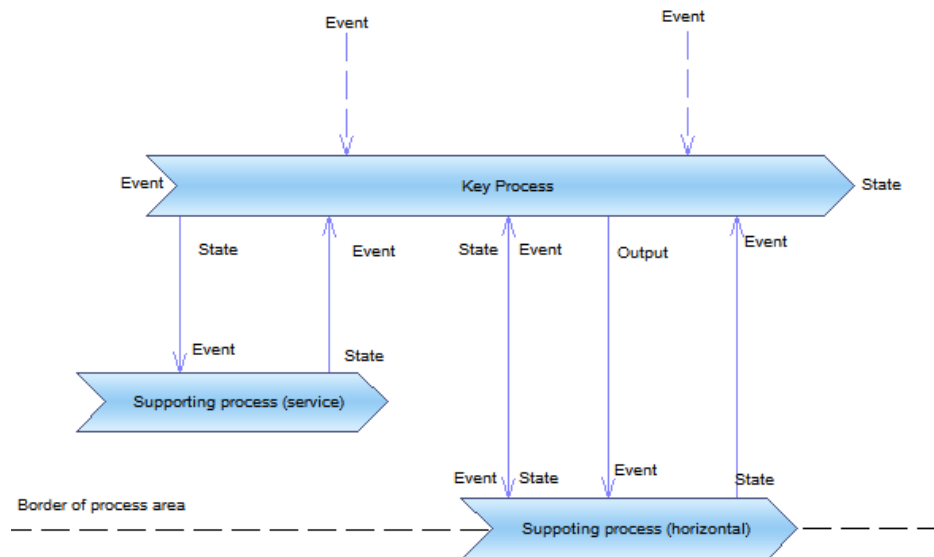
Abovementioned definitions in general say that business process turns inputs into outputs. This processing is possible due to sequence of activities set for achieving an objective. Every process should have a dedicated person, who is responsible for a given process. That person do not necessary perform actions within the process. Besides a decision-maker, all stakeholders should be defined and known. All people involved in process share a common purpose and work to achieve a common target. They have a framework or process design, which tells what is done by which employee, where and when [HAMMER, 2009].

Other than inputs, outputs and responsible employees, involved in process, certain resources are used. Those resources should be identified and known as well. Business processes should correspond with business strategy. Company's strategy consists of vision and objectives as well as operations performed to achieve given goals, which are necessary for customer satisfaction.

Summarizing definitions above the following list of business process properties can be compiled:

1. Has a goal
2. Has defined scope, input and output
3. Uses resources
4. Has order of activities
5. Creates or adds value to the recipient during the transformations within the process.  
Recipient can be either external (customer or market) or internal

Each activity in business process should lead to meeting goals they have in common. On Figure 1 is displayed the general scheme of a business process. The general scheme of the business process provides a general view of the process of the organization and its surroundings. Business process transforms inputs supplied by a particular supplier to the outputs in order to achieve the stated target, required by the customer. The owner of the process is the role that collects suggestions to improve the process and on the basis of these suggestions tries to optimize owned development process.



**Figure 1. Global processes model. Source: ŘEPA, 2007**

Business processes can be categorized according to several dimensions. They can be grouped as global or detailed, managing or supporting, internal or external etc.

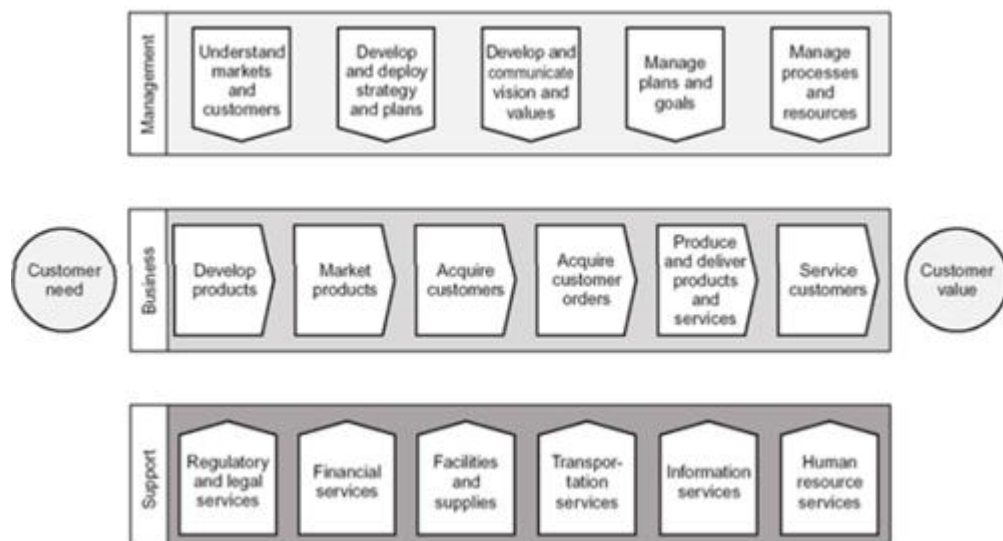
Organizations apply several types of processes to perform work. According to [PALL, 2000], nowadays in most enterprises business processes are mainly divided into three important types:

- Management processes
- Business processes
- Supporting processes

Managing processes are derived from company's strategic objectives and vision [WHA QUALITY CENTER, 2012]. They generally provide direction for an organization. By setting goals and coming with strategy to achieve them, senior leaders transmit goals to lower operational layers and manage performance goals with design of an enterprise. Management business processes govern resources and other business and support processes used in the company. According to [CIENCIALA, 2011] managing processes can be viewed as part of supporting business processes group.

Business processes implement the main subject of business. Given group of processes is value-creating and concentrates on unique business competences. Processes add value to process inputs in the organization and in the end lead to customer satisfaction. Thus, this set of processes is strategic for the organization. As companies may have tens and hundreds of different processes they only have only a few business processes. In that context business processes can be called main processes [CIENCIALA, 2011] or key processes [ŘEPA, 2007].

Support processes are essential for other processes. They exist to assist to the organization, thus outputs of those processes serve internal customers, which use core business processes to satisfy external customers' needs.



**Figure 2. Business processes scheme. Source: WHA QUALITY CENTER, 2012**

Processes may be grouped in a different manner, depending on the environment of the enterprise. According to [ŘEPA, 2012] there is only one main and comprehensive classification, which can be applied in wide range of organizations. This type of grouping business process is derived from the primary function of the organization. All processes are divided to key and supportive business processes.

### **1.3.1 Key processes**

Key process is a business process, which fulfills the primary function of the enterprise. That means that during key process created a value, company profits from. The



main distinguishing feature of that process flows through the whole enterprise combining almost all types of jobs in that organization. Input for given process is customer's need and its output is a service or product, that satisfies this need. Key process is set based on product or service provided by the organization. Each product or service, which completely differs from other outputs, comes out of an appropriate unique key process. In contrast to it in tradition hierarchical organization processes are not defined as well as sequence of activities running thru the whole organization does not exist. Instead, key process are divided into many activities and thus lost in different organization units across the enterprise. This makes global view on key activities impossible.

### **1.3.2 Supporting processes**

Unlike the most important key processes in the organization, supportive processes do not create a value to external customer. Those processes exist in order to support main ones either directly or by supporting other supportive processes. According to [REPA. 2012] supportive processes have two subcategories:

- Service or sub-processes
- Horizontal supporting processes

Sub-processes concentrate on producing specific service or product. After output is created, it is used by parent process, which consumes its sub-process's service. Horizontal process used as service-provider for surrounding processes. Horizontal process has its own independent behavior. The reason, why horizontal process cannot be considered as sub-process is because it provides multiple services to multiple processes.

Global model is intended to understand the whole context of the processes-oriented system by showing different types of processes, their interactions between each other and process attributes. To give deeper understanding of processes in the organization, the descriptive table of processes can be used.

Table 1. Descriptive table of processes. Source: [ŘEPA, 2007]

<b>ID</b>	<b>Process identifier</b>
Name of process	Name of process, which represents its meaning, specification and scope
Strategic goals	Strategic goals or primary functions, which are supported by given process
Product/services	Outputs of the process
Process specification	Short description of process meaning and process content
Process owner	Parameters or name of process owner
Process customer	Process customer (specific or abstract role of the customer)
Areas to improve/problems	Areas of potential (or necessary) improvement or changes of process
Metrics	Performance metrics of process
Starting event	Basic initiative launching the process
<i>Circumstances</i>	<i>General circumstances for launch/run/end of process</i>
Information systems	List of Information systems or applications, which support process or process activities
Documents	Guiding documents of organization and other regulations related to process

Besides the global view on business processes, there is another dimension used for modeling process system called detailed model. That dimension models run of the process and concentrates on details like small activities and states. That models are discussed in next chapters.

## **1.4 MMABP**

Business processes modeling application in further chapters is based on MMABP technique [ŘEPA, 2011]. MMABP (Methodology of Modeling and Analysis of Business Processes) consists of multiple views on real world related to each other. In enterprise business system two basic entities of interest existing – objects and processes. They can be also called as model of static aspects and model of dynamics of reality. Object view describes so called “business rules” – rules and restrictions valid for business system. Business processes view defines goals of enterprise and steps or activities leading to these aims fulfillment. Either of given dimensions of reality can be examined in terms of global or detailed view. After combining those dimensions, four views arise: Global model of business processes, global model of business objects, detailed model of business processes and detailed model of business objects (Figure 3).

Each of given views has its own scope and purpose and can be modeled using various tools and methods. In order to model business process on global level can be used Eriksson-Penker notation and diagram. Detail view to processes is described by using standard called BPMN (Business Process Model and Notation). Static aspects of reality or structure of objects on global level are represented by using class diagrams. Full explanation of processes on a lower level is represented by using state chart diagrams.

# Business System Model

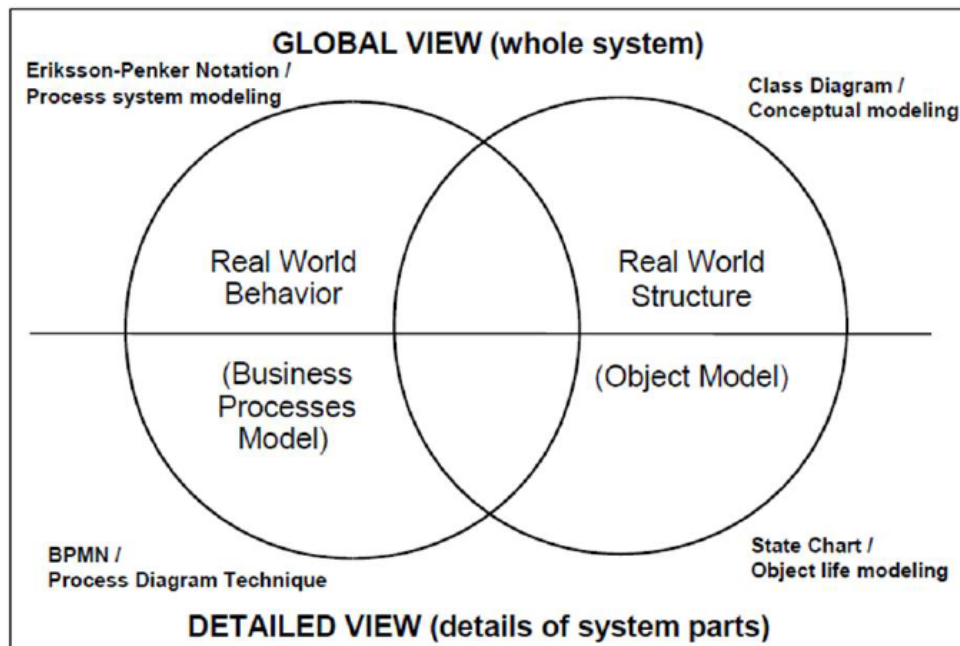


Figure 3. Information model dimensions. Source: Řepa, 2013

MMABP is based on the following three basic principles:

- The principle of modeling is based on idea of the real world modeling [ŘEPA, 2007]. Entities and relationships between those entities are taken as a starting point to model information system's entities and their relationships. That principle is used in data model, which provides specific definition and format or a structure for data used within information systems. Entity Relationship Diagram is actual model for data modeling used to display network of objects as a model of a reality [WHITTEN and col, 2004].
- Principle of three level architecture describes information system design on different data-model levels:
  - Conceptual level describes the scope of the model and reality of specific domain. It omits technological and implementation aspects

being a first step in organizing requirements and describing a system.

- Technological level describes data organization and structure. In addition to that, technological model of information system deals with data processing and defines given system in particular technology chose to model the reality.
- Physical level describes physical means of development environment in given system and is responsible for implementation of technological solution.
- Principle of abstraction is based on decomposition of the modeled system elements to the detailed level. That principle expresses the way the individual facts are analyzed in detail through hierarchical abstractions. Each level of abstraction contains a description of elements their relations to each other. Therefore, elements on the higher level are abstract. Two basic types of abstraction are aggregation, which is specific for functional model and generalization, which is mostly used in data model.

For modeling itself two standards defined by [OMG, 2011] are used: BPMN and UML (Unified Modeling Language). Those standards are used for modeling in practical part of that paper.

Further steps are defined in MMABP in order to structure and define modeling of business processes [ŘEPA, 2011]:

- Step zero: Events and external actions analysis.
- Phase one:
  1. Key elementary process identification
  2. Analysis and design of elementary processes relations
  3. Detailed analysis of elementary processes

4. Analysis of elementary processes and consistency ensuring
- Phase two:
    1. Object analysis of products
    2. Identification, analysis and design of key processes
    3. Key processes analysis and consistency ensuring
  - Phase three:
    1. Relevant objects analysis
    2. Supportive processes identification analysis and design
    3. Analysis of the system and consistency ensuring

Given phases generate and use different inputs and outputs. Following inputs and outputs are used in MMABP:

- Common global inputs
  - Object model of the enterprise
  - Reference business model
- Specific intermediate products
  - List of events and reactions
  - Lists of elementary processes
  - Products object model
  - Enterprise object business model
  - System of elementary processes
  - System of key processes

- Process model of organization

The following techniques are used for modeling:

- Conceptual modeling
- Objects lifecycle modeling
- Processes system modeling
- Processes procedure modeling
- Organization process structure modeling

## **1.5 BPMN**

Business Process Model and Notation is a graphical representation for describing business processes. MMABP methodology uses set of BPMN elements as a tool to represent detailed process diagram.

BPMN objects belong to four basic groups [OMG, 2011]:

- Flow objects
- Connecting objects
- Swim lines
- Artifacts

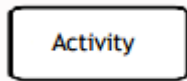
Set of elements used by MMABP is limited though. Following constructs are used in later chapters to describe detailed flow of business processes:

- Event. Different types of events are shown in shape of a circle. Basic events used are starting, ending and time events. Those events are initiatives, which happen in real world and are considered as inputs. Event is shown on figure 4.



**Figure 4. Events indicating start point and timer events. Source: OMG**

- Activity. Rounded-corner rectangle, which describes unit of work should be done. Activity is shown on figure 5.



**Figure 5. Activity representation in BPMN. Source: OMG**

- Gateway. That element is represented by rhomb shape and determines decision-making point in business process. Gateways are used as a process state to show, that process waits for an external event. Logical operators may represent merging or forking of process flow, caused by result of event from outside of the process. Gateways AND, XOR, apart from OR gateway, should be used both at the start and at the end of branching activities. Gateways are shown on figure 6.



**Figure 6. Exclusive, Inclusive and Parallel gateways. Source: OMG**

- Data. Data object may represent information used in process or output of given activity. That object is used to increase model transparency of model and visualize a situation, when work activity generates document as its output. That source of information can be represented by e-mails or business documents. Data are shown on figure 7.



**Figure 7. Data object representation in BPMN. Source: OMG**



## 1.6 UML

UML is a modeling language developed in OMG. That language can be used in many ways in order to model almost any objects and relations from the real world. Thus, notation is commonly used to describe object model in MMABP. As object model may be divided into global and detailed views, UML is used to model class diagram and state-chart diagrams [ŘEPA, 2007].

Class diagram is intended to show structure of the system from static point of view by ordering entities in the system. Class represents particular entity of the system (e.g. employee, invoice, organization unit). All instances of one class have the same behavior and attributes. Classes are graphically represented as rectangles with three boxes, containing information about name of the class, list of class attributes and list with methods utilized within the class.

Classes may have relations to other classes. The main inter-class relationships are the following:

- Association. That kind of relationship simply states that there is some link or a dependency between two or more classes. Class A may be linked to class B in order to show that instance of class A needs to know about an instance of the class B in order to perform its work.
- Aggregation. In cases where there is a part-of relationship between Class A (whole) and Class B (part), aggregation is more appropriate and brings more concreteness than association. Aggregation implies a relationship where the child class can exist independently of the parent. Assuming parent class is school and child class is student, relationship between those two classes can be described as aggregation since removing the school does not remove any student.
- Composition. Apart from aggregation, composition implies a relationship where the child cannot exist independently of the parent. Lifecycle dependency between class A and class B is very strong. That means, that if class A is removed, then class B is deleted as well as a result.





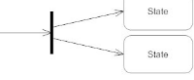
- Inheritance. Another type of relationship used in class diagram is inheritance. Inheritance implies strong hierarchical relationship. In that case class B, which is a subclass of class A inherits all its attributes.

Detailed object model is represented by state-chart diagram and describes components of the system in a deeper level. Given diagram shows lifecycle of a particular class by using states and transitions. Each transition represents external or internal event, which affects object. Each state of the class waits for an event or reflects consequences of occurred event.

Following elements are used in order to present abovementioned lifecycle:

- Initial Event. A filled circle represents event, created an object.
- Final State. A filled circle inside another circle represents object extinction in the system.
- State. That rectangle with rounded corners represents situation or object's reaction to a certain event during the life of an object.
- Transition. Arrow represents the procedure between states of an object. Transition is described by two attributes: cause of transition and reaction to it.

**Table 2 State Chart Diagram symbols. Source: Author**

	Initial Event
	Final State
	Transition
	Regular State
	Forking



## 1.7 Eriksson-Penker Notation

Eriksson-Penker notation is an extension of UML. That notation is used for processes overview on a global level within MMABP methodology. For deeper understanding of process run BPMN is used in this methodology.

Eriksson-Penker notation supplies organization with four basic views on it. The first view captures strategic goals of the enterprise. Connection with business processes leads to better understanding of enterprise itself. The second view shows resources of the enterprise consumed by business processes: knowledge, people, materials etc. The next third aspect of notation is processes and outputs created by activities in the organization. And the fourth view on enterprise focuses on internal interaction between specific units of that enterprise.

## 2 Process Management introduction in dental clinic

Reengineering pursues detection and description of business processes. Process management requires changes in management concepts. That part of the paper is dedicated to process management implementation in real dental clinic situated in Ufa, Russia. Next chapters describe current status of the organization. Given dental clinic is currently going to adapt process management principles and information system, which should support existing business processes.

### 2.1 Company description

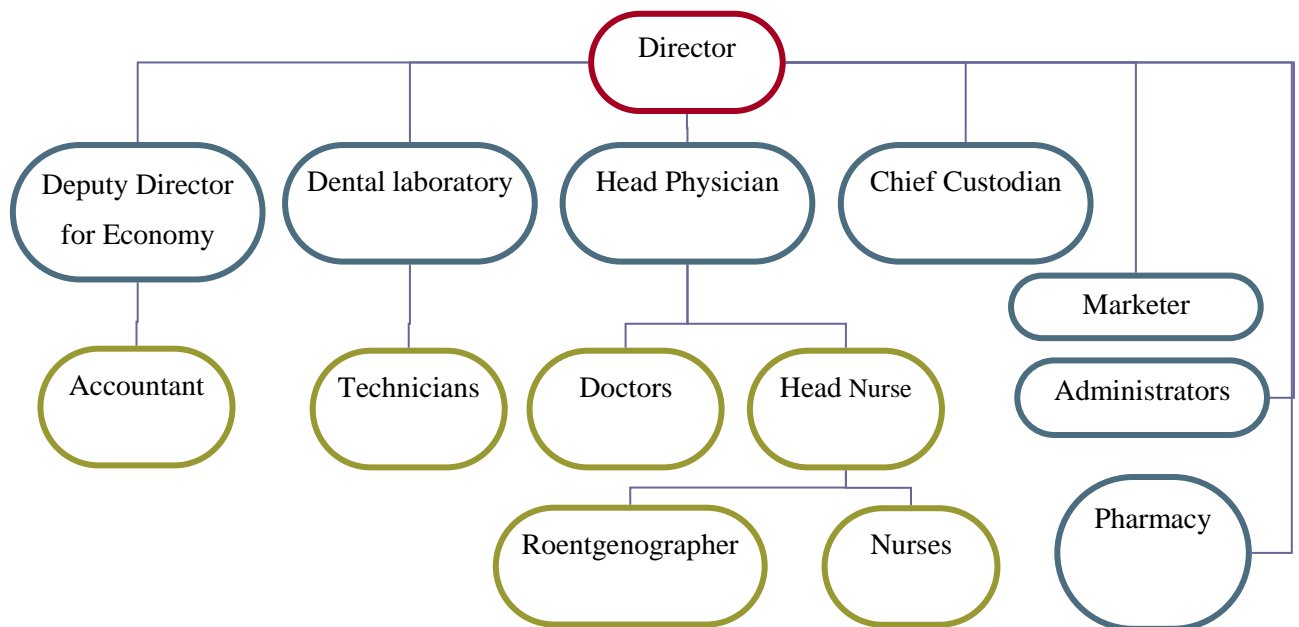


Figure 8. Organizational structure of the medical clinic. Source: Author

Director has the greatest decision-making power in the organization. He is in charge of hiring senior and middle-level personnel. The duties of the head of organization include organization of work of senior and middle-level personnel, concluding contracts with partner organizations.

Chief Medical Officer or Head of Physician is the deputy head of the clinic for inter-organizational relations. He makes general decision for maximizing profit of the clinic. He builds treatment process as it is necessary condition for a modern dental care.

Monitoring compliance with medical and legal documentation according to the current legislation of Russian Federation is important part of his responsibilities as well. Apart from that head of physician is obliged to control communication with partner companies, monitor timelines for sending, receiving and signing documents. Head of the clinic and the head physician directly manage, coordinate and control all senior medical staff. Together whose two directors develop and implement development strategy of the clinic in market conditions.

Chief Custodian is the deputy head of the clinic in terms of material support of the clinic with the necessary equipment (furniture, office supplies, cleaning supplies, heating etc.). His duties include the record keeping of available and functioning property of the clinic, retirements of equipment after expiration, ensuring clinic with all needed supplies by establishing contacts with suppliers. He is responsible for all property under his jurisdiction.

Head nurse is appointed to her role by the head of the clinic. Her main duties include organization and monitoring work of nurses and middle-junior medical staff. She is responsible for receiving, recording and reporting changes related to inventory materials important to clinic for its fluent run. Head nurse submits report on work of the clinic to the head physician at a given time in the prescribed form.

All nurses are subordinated to a senior medical staff as well as to the head nurse. Nurses are assigned to doctors or rooms, where currently their help is needed. One of nurses takes charge for medicines and medical materials presence for current day. Junior medical staff subordinated to a senior medical staff and is hired by the head nurse and the head custodian.

Administrators subordinate directly to the director or to their manager. Their duties include work with organization's documents, dispatcher functions. They also have to know units of partners' organizations and cooperate with others as part of their communication duties. Also, administrators work with cash machine and receive payments from customers for medical services.

One of the important units in clinic's structure is reception. Two roles are occupied in daily reception work. The first is an administrator, who is involved in interaction with only clients who signed a contract with the clinic either themselves or through their employer. He keeps the record of those patients and issues directions for examination by proper specialists. Second role is administrator-cashier, who works with cash register, receives payments from patients for clinic services, calculates checks, keeps record of patients and performs cash collection. Third role is a physician-statistician, who fills out clinical cards for each patient and keeps their record. Apart from that, he keeps record of insurance policies and submits bill payments to the chief physician. He organizes collection and processing of medical statistics. Another important duty is ensuring accuracy of information in audit and reporting documentation. All employees working on reception report directly to chief physician and at some point of their activities to head nurse. Several times a month those employees (except of cashier) perform courier work visiting laboratories cooperating with the clinic, state institutions and partner organizations.

To complement its services, clinic also has its own in-house pharmacy, radiology and laboratory, which carries out a significant part of the work. Dental laboratory in general solves problem of teeth prosthetics and produces ceramics, temporary crowns, removable prosthetics etc. Laboratory staff conducts the most common and standard testing for patient treatment process. That means laboratory is in charge for all possible blood tests. Complex tests, which laboratory is unable to perform, are outsourced.

Roentgenographer performs X-ray examination for the maxillofacial system in standard and atypical projections. Currently there is no radiologist in the clinic, who identifies morphological and functional signs of disease and provides advice for doctors in his field. Thus doctors are reading X-ray photographs themselves. In case of more complex analysis needed, external specialists are invited for collaboration.

Time to time during holiday seasons specialists are temporarily invited, so they take patients during specific hours.

## **2.2 SWOT analysis**

For better understanding of company's stand on the market the author performed interviews with management and key employees in order to compose SWOT analysis.

**Strengths:**

- Reach experience and knowledge of leadership in managing the company
- High quality services
- Presence of high-qualified senior staff
- Reputation among the clients
- Long-term cooperation with partners and suppliers

**Weaknesses:**

- High dependency on some individual employees
- Very little IT support of the business
- Lack of information about client
- No well-defined responsibilities
- High costs of dental equipment
- Risks of losing medical staff due to competitors' activity

**Opportunities:**

- Improvements of quality and availability of services for population
- Implementation of new services and methods
- Opportunity to acquire specific client groups via media
- Acquiring new customers by signing contract with big organizations

**Threats:**

- Increase of expenses due to changing state customs procedures

- Increasing level of competition in the city
- Decreasing demand level due to general decrease of incomes and unstable financial conditions
- Frequent changes in legislation

## 2.3 Objectives

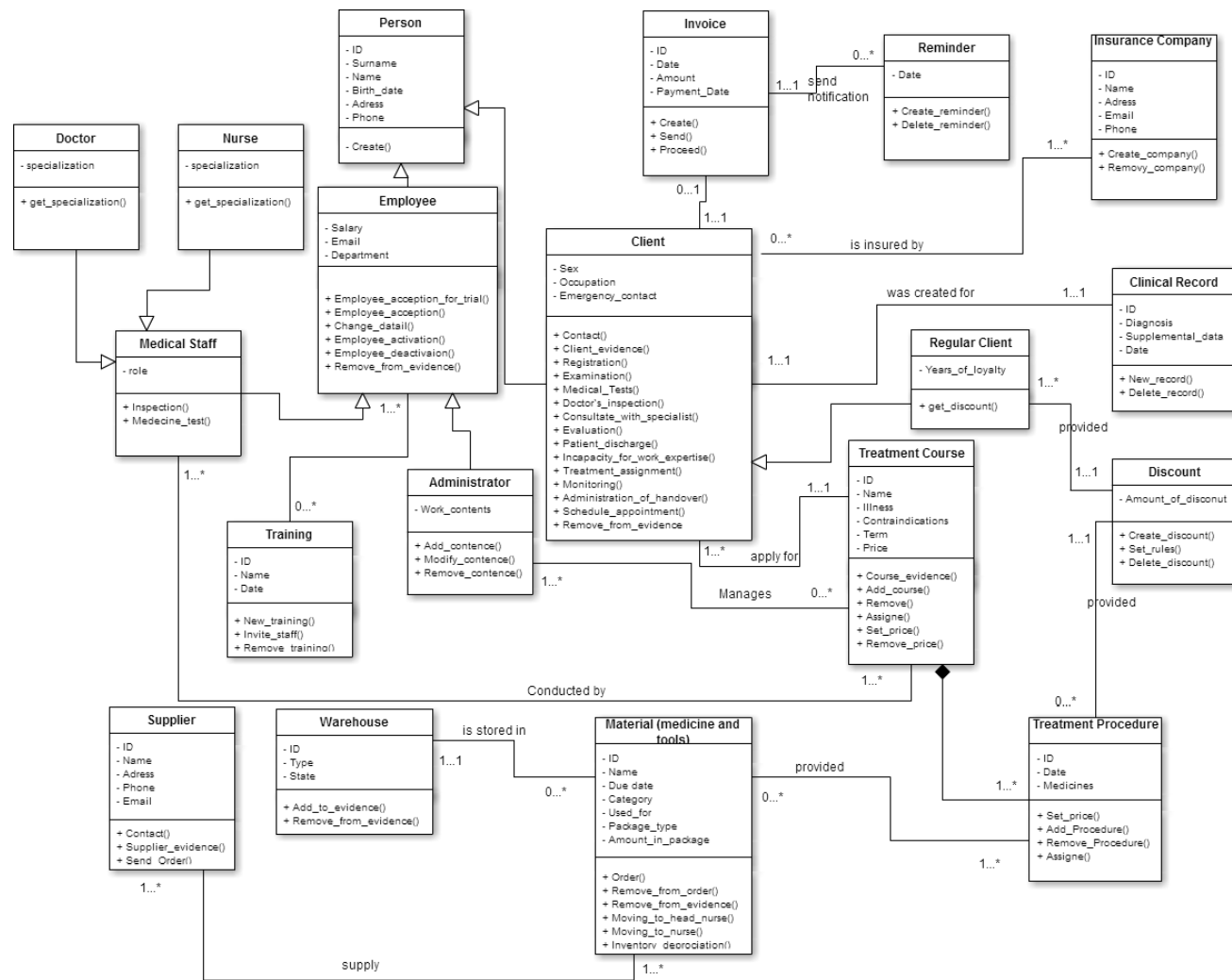
After creation of SWOT analysis and its following consultations with management has been compiled table, that includes goals, which the company wants to achieve.

Target	Priority	Date	Metrics
<b>Introduction of complex Medical Information System</b>	High	1.12.2016	All employees are trained; Requirements fulfilled;
<b>Process management introduction to company</b>	Medium	1.10.2016	Processes are analysed; All employees are acquainted with the new processes;
<b>Start massive campaign on new client acquisition</b>	Medium	1.9.2016	New customers

## 2.4 Conceptual model of the organization

Conceptual model of a business is a description of key elements of the system and the relationships between them. Each object is marked a by particular name and indicates the actually existing entity. Figure 9 shows a conceptual model of the organization, which represents a modelled system as a set of classes and relations between them.





Conceptual model is shown on figure 9 in form of class diagram of chosen medical organization. It consists of 19 classes.

In the diagram association, composition and generalization relations are used for better entity relations representation. Hierarchical generalization relation is used for the following entities: Person, Employee, Medical Staff and Client. Inheritance is used to share attributes of the parent class with child classes. But at the same time all child classes have their unique attributes. Composition helps to show relations between Treatment Course and Treatment Procedures. The most important classes here are Client, Material, Employee, Treatment Course and Treatment Procedure. Life-cycle of some of them is described in a following part of that paper.

## **2.5 Client life-cycle**

To show life-cycle of client, author decided to focus on it from different points of view. Examined views are presented from marketing and patient treatment process sides.

### **2.5.1 Marketing View**

Marketing view of life-cycle of the client is divided to following types:

- Getting new client
- Discounts for active client

#### **2.5.1.1 Getting new client**

On figure 10 life-cycle of “Active” and “Potential” customer is shown. All clients are contacted with proposal and bases on their feedback they are categorized either to “Potential” or to “Active” group. If “Potential client” accepts proposal, he changes his state for an “Active client”, in case of rejection “Potential client” will be removed from database. If client after being contacted accepts proposal, he will be marked as “Active client”. In case of client decides to leave, he will be removed from database.

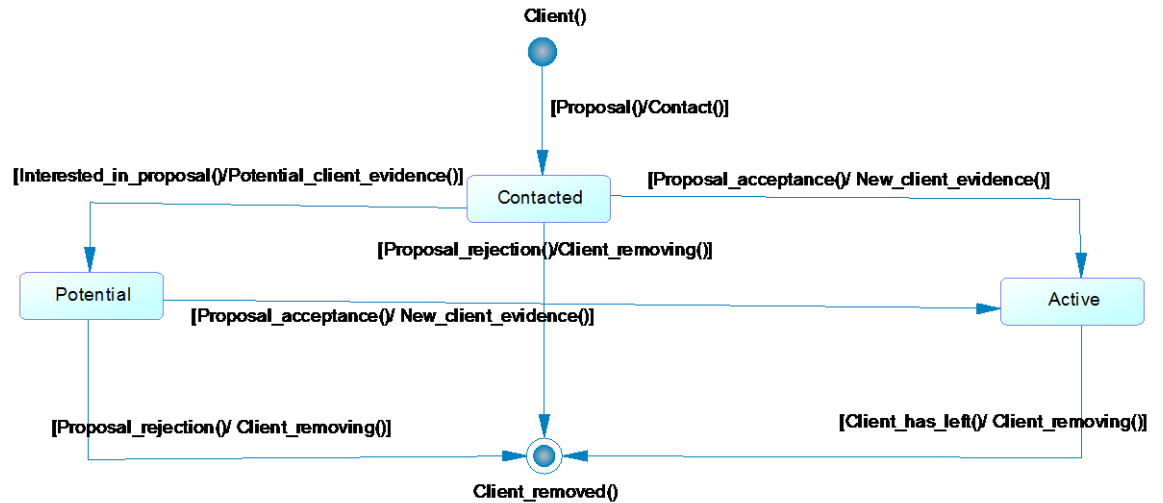


Figure 10. State chart of "Client" class. Active and Potential. Source: Author

### 2.5.1.2 Discounts for active client

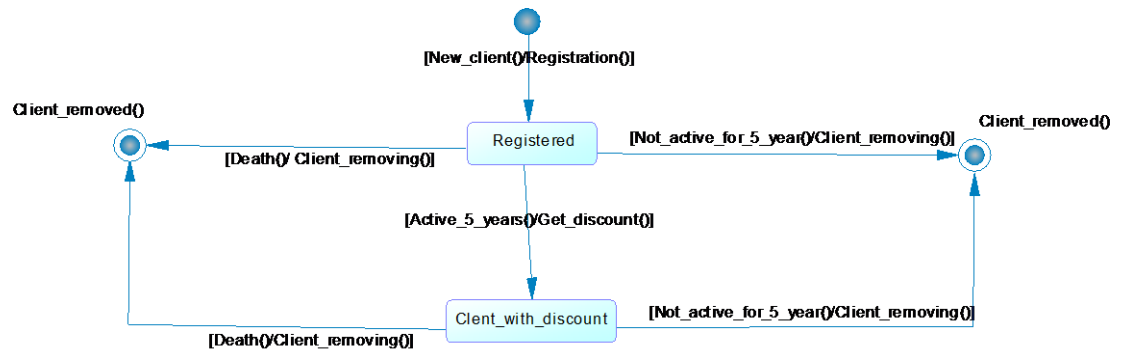
All new clients should go through process of registration. When they are in “Registered” state, they can get a loyalty discount after being active for 5 years. In case of not being active for 5 years, client will be removed from database. Also in case of client death, he will be removed from database as well. Described state chart is shown on figure 11.

### 2.5.2 Patient treatment process

On figure 12 customer involvement in treatment process is shown. After arriving a new client registration is needed. When client is in “Registered” state, clinical record is created and client can schedule an appointment for examination. For the reason of optimization, the examination, medical tests and doctor inspection processes are running in parallel, dependent on client’s decision, he can be transferred to either “Medical tested” or “Inspected” states at first. Client cannot avoid any of this states. When client is “Inspected” and doctor is not sure, client should be “Consulted by specialist”.

After all examinations are done, evaluation process proceeds and client is in “Diagnosed” state. Evaluation process generates new states for client, dependent on client’s condition. In case of a good client condition, patient discharge is following and client gets to “Discharged” state. At this state client can choose, if he wants to be

monitored or he can leave clinic. Next state is “On treatment”, client gets to this state if treatment is needed. After treatment client should be examined again and schedule an appointment. If client is evaluated as not able to perform work activities, he is moved to state “Incapacity expertise” and after getting a disability verification he can move to “On treatment” state. The last possible client’s option after evaluation is complex treatment. In case if clinic cannot provide needful service, client gets to a state “Patient handed over” and he is served in another medical organization, which can provide necessary service.



**Figure 11. State chart of "Client" class. Client with discount. Source: Author**

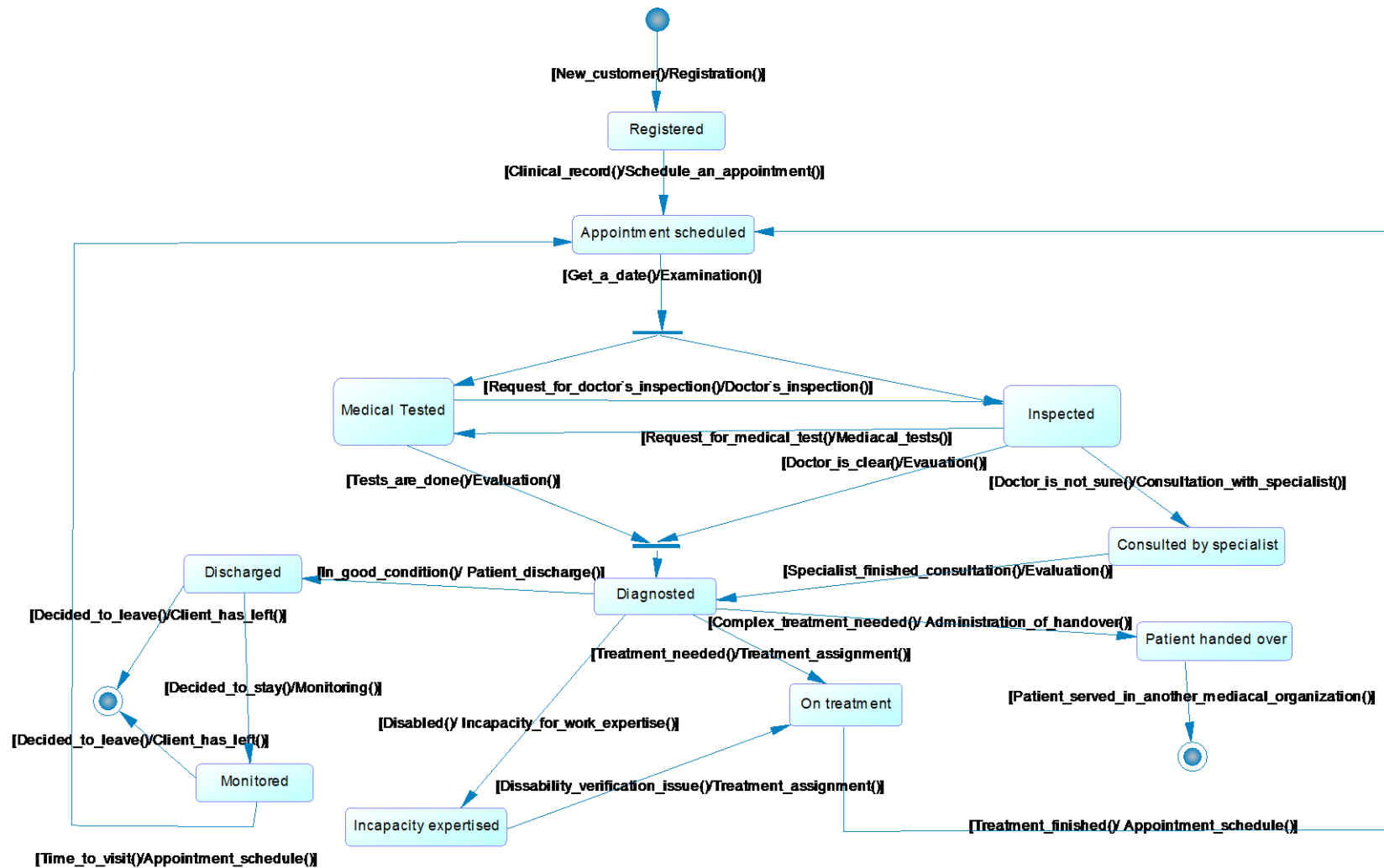


Figure 12. State chart of "Client" class. Patient treatment view. Source: Author

## 2.6 Life-cycle of material

In medical organization life-cycle of material starts from order. When material is “Ordered” from supplier, there is a possibility that material is removed from production. In that case material is removed from database. When ordered material is received it is “Stored in Warehouse”. Based on request for material it moves to head nurse and to nurse. Therefore, material gets states “In clinic’s medicine chest” and “On reception”. At all described states material expiration could happen, then it is removed from evidence. After nurse gives medicines to patient, material life cycle ends with inventory depreciation. Described state chart is shown on figure 13.

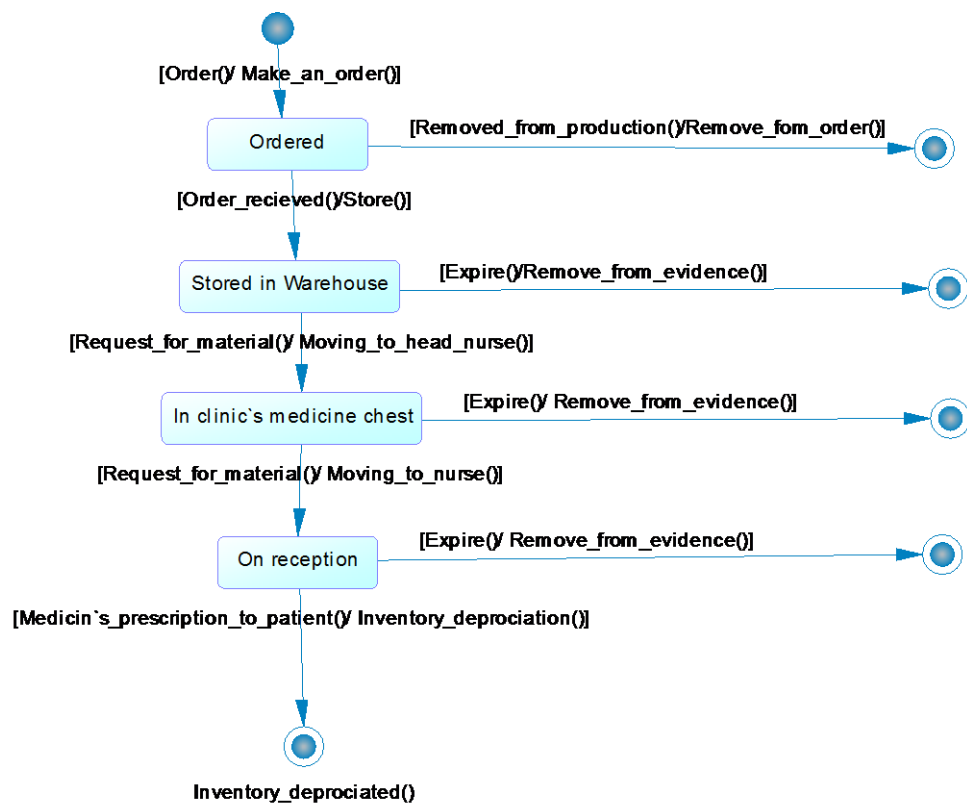


Figure 13. State chart of "Material" class. Source: Author

## 2.7 Life cycle of employee

New employees come to chosen medical organization based on interviews. After successful interview employee is accepted for three months of trial period and gets state “Employed for trial period”. In case of failure during trial period, employee is dismissed and removed from evidence. If trial period ends successfully, he is accepted

as long-term employee. “Employed” is the main state, which means employee is active and can participate in activities and perform regular work activities. In case of “On Vacation” and “Sick” states employee is temporarily unavailable and employee deactivation and reactivation methods should be done. Employee’s life cycle ends with employee dismissal and in this case he is removed from evidence and contract terminated. Described state chart is shown on figure 14.

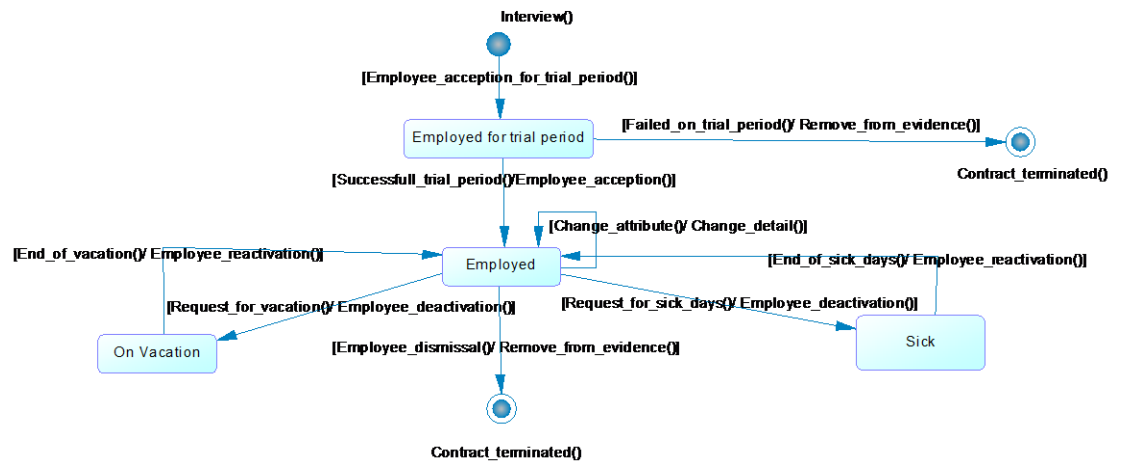


Figure 14. State chart of "Employee" class. Source: Author

## 2.8

## **Process model of medical organization**

### **2.8.1 Global process model**

As mentioned in the previous chapters, process map is a model of the processes that take place in the organization. Process map has to be a model of reality, so that it is possible to get a fair idea of company functioning. Essential part of building a process model is to take into account the views of the management. But from the other hand, in no case employee views on processes and activities cannot be omitted. All levels of management and employees should participate in sharing knowledge and building of the process map. If only one of the company sides is interviewed, then the analysis will use incomplete information. Performing full analysis prevents from the situation, where procedural map represents only a part of reality or even inconsistent with the real world. Each process should be mapped only from process owner's point of view, but also from the perspective of the person who performs it.

Since the described stomatology clinic has around 30 employees, it was possible to consult models and verify, if they match the reality from employees' perspective. Mapping the basic context of procedures is based on organizational structure, information about activities, entities of the company and occurring events.

Global model draft was based on interviews conducted with management. Output of such conversations was a list of activities with their outputs and their approximate order. Author categorized list of activities from interviews into basic processes. Besides collecting activities performed in the clinic, author tried to find and distinguish activities, which add value and thereby identify key process. The next steps were aimed on identification of supportive processes and processes which can be outsourced.

As main services clinic provides are activities related to diagnoses, prevention and treatment of diseases and related structures and tissues in jaw and facial area, main key process of the clinic is patient treatment. That process maintains company existence, thus it is the most important process.

On the other hand, some processes, which are important and essential for company existence, are not critical from global process map modelling perspective. Given important



processes are not considered as processes, rather process areas with defined responsibilities and activities. From model perspective they are considered to be outsourced activities. Such processes as accounting and ICT support are almost not connected to the other processes in the global process diagram and especially to the key process. Thus they are omitted in that chapter. Further part of the chapter describes transformation of the input of the key process (customer arrival or request) to the output (satisfied customer).

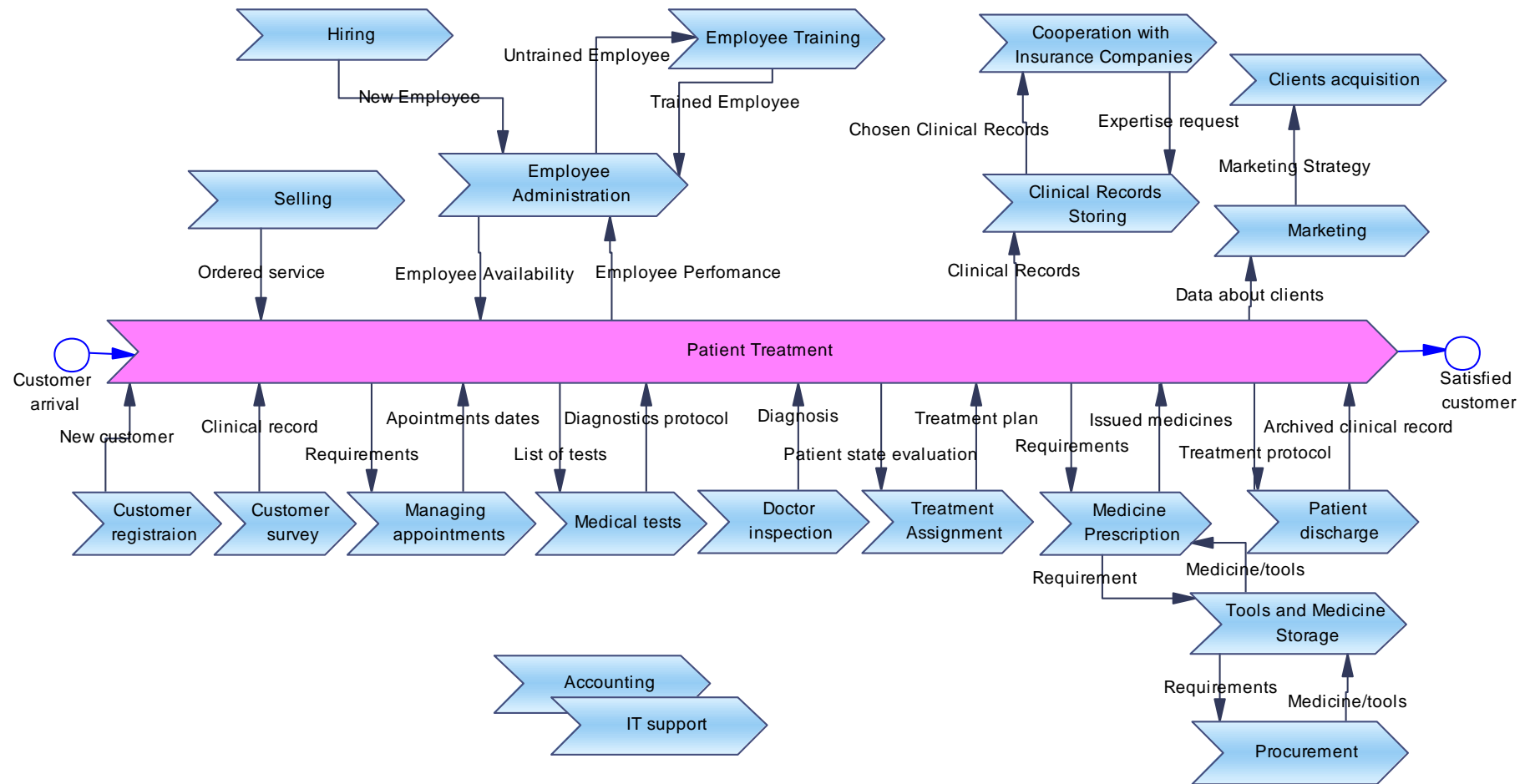


Figure 15. Global process diagram. Source: Author

Reworked complete model of global process model is presented on figure 15. It contains one key process, 12 supportive processes, which are directly related to the key process and six processes indirectly related to the key process. Here key process represents managing activity of the following subordinated processes as well as the treatment procedure itself:

- **“Customer registration”** is executed immediately after client has arrived to the clinic facilities with intention of receiving organization’s services. This process is executed by administrators on the reception of the clinic.
- **“Customer survey”** executed by administrator as well. The intention of given process is to gather basic information about the client including basic data, occupation, patient complaints, previous illnesses. Patient’s clinical record is formed in order to serve as the most important medical document, which track all changes during patient treatment. Apart from that, clinical record is used as an important legal document, allowing insurance companies to control correctness of treatment.
- **“Managing appointments”** may be executed by administrator in case of standard and obligatory medical tests or by nurse on duty, based on patient’s complaints or requirements. Nurse calls to diagnosticians or other nurses in order to find suitable date for an appointment. That process is time-consuming and demands cooperation on several sides to find the best suitable date. Often personnel use their own phones and spend their own money to call other colleagues.
- **“Medical test”** in form of laboratory tests or diagnostician appointments is a process, which intended to narrow down range of possible illnesses or to diagnose hidden issues. Depending on patient’s needs, complaints or history of illnesses process timeframe may vary. Also the logistic problem of managing clinical record between patient, clinic reception and doctors might be a problematic area as it demands cooperation and needlessly consumes time.

Nurses are often placed in role of couriers, spending their time of non-production activities.

- **“Doctor inspection”** is a process executed by therapists, where therapist interviews patient and analyses the outcomes of previous processes such as initial survey and medical tests.
- **“Treatment assignment”** is performed by the therapist. Based on diagnoses, patient’s needs or allergies, doctor sets list of necessary activities and their dates – a treatment plan. Medicine prescription follows treatment assignment.
- **“Medicines prescription”** is a set of activities, where patients get medicines and other needed medical inventory. That process is a highly important as it is controlled by state and should be consistent with the legislation. Activities connected with personified material expenditures, transportation between clinic units and material amortization are time-consuming and may be optimized by its formalization in order to achieve better performance. Processes “Tools and medicine storage” and “Procurement” are highly integrated.
- **“Patient discharge”** process. In case of patient has successfully completed the course or has not been assigned to a treatment at all (case of employees’ entrance checkups), they are discharge from a treatment until next visit.
- **“Selling”** process among the rest contains invoicing and financial documentation processing. That process’ output brings new service order to a key process, for instance, if client orders service “teeth whitening”, the order is reflected in the key process. The service may be paid from different sources. One of that source is client himself paying full amount of the service, second option is client’s insurance company and third is a combination of the first two options. Client pays only in cash, while insurance companies transactions are executed via bank accounts.

- **“Employee administration”** process manages internal and external employees. External employees are invited during mainly during holiday seasons in Russia. Given process utilizes outputs of other two processes “Hiring” and “Employee training” for getting new workers and managing their skills while required.
- **“Clinical records storing”** process manages activities connected with the clinical records. Process is executed by nurses. Each patient visit is shortly noted in clinical record. Each new protocol of medical tests or diagnostics, treatment plan and its outcome is being continuously attached. All that documents are highly important and often used by different employees. Thus matter of transition to electronic option is very important for the organization. Once in a quarter or half a year, partner insurance company requests certain amount of archived clinical record for inspection. Insurance company checks if legal requirements and treatment methodologies were used correctly. If problems occur, clinic gets potential risk of being sanctioned by state authorities. Described process activities are grouped into **“Cooperation with insurance companies”** process.
- **“Marketing process”** is a group of activities executed by marketer and medical staff in order to analyze services popularity among population, introduce new methods and services as part of treatment to management, analyze client conversion. It initiates media campaigns in order to acquire new clients, either individual or whole organizations and institutions.

### 2.8.2 Detailed process model

Detailed analysis of business processes of the clinic is conducted using BPMN notation. That chapter is dedicated to detailed analysis of key process and the most vulnerable and error-prone process in the organization. They are described in detail in the following parts of the paper.

### 2.8.2.1 Detailed model of the key process

Detailed model of the key process is shown on figure 16. From the global model view, given process should contain eight supportive processes, but in case of detailed model, other processes were added or one existing process was divided into several activities in order to show full picture of the process.

Process starts with an event **“Customer arrival”**. Depending on the customer has been registered before or not (decision **“New customer?”**), he either is registered for the first time or customer survey is initiated.

If customer was not registered before in the clinic, **“Customer registration”** process triggered. Anyone can be registered in any clinic in Russia as long as they have insurance policy. Customer can be registered in a private clinic at his own expense. Output of that process is therapists visit schedule. Patient can get a ticket to visit a therapist with his surname, room number and assigned number written on the ticket. Patient shares basic data about himself and after that is done or arrived patient shares information about his registration, administrator or nurse initiates **“Customer survey”** process.

**“Customer survey”** process collect all necessary data about the patient: education, address, occupation and employer, social status, previous illnesses patient suffered, information about disability, health complaints and etc. Based on provided information a new clinical record is formed or the existing one is actualized. The output of customer survey is ready clinical record, which patient or rather nurse is carries to doctors. Clinical record creation and filling it out is a necessary step for starting further diagnostically and treatment processes.

**“Medical tests”** process is executed by laboratory workers and diagnosticians, who carries out tests in order to narrow-down possible hypothesis of a disease and provide information to a therapist. Each diagnostic generates an output in form of diagnostics protocol, which is attached to a clinical record.

**“Doctor inspection”** process is executed by the therapist patient was assigned to. Therapist interviews patient, trying to make a whole picture of a disease. If doctor has a

feeling, that he needs more information on patient's status in some specific area, he may send the patient to a specialist (for example nutritionist), thereby triggering process **"Consultation with specialist"**. Currently, doctor inspection is held only after all medical tests are done, which causes delays in treatment process and forms a bottleneck of process as queueing in waiting rooms or hallways. Queueing has a high negative impact on the clinic's prestige. Psychological effect in form of association with bureaucratic state medical institutions affects patients and they are not willing to return and are dissatisfied with the clinical service. That part of the process was modified by the author as it is the weakest and the most sensitive part of the whole process for customers.

For payment tracking reasons, process **"Provided services recording"** and **"Invoicing"** are ran in parallel to medical tests executions and doctor examination. The first process is intended to keep track of all received services and their cost. Invoicing ensures that client is able to compensate company expenses.

Process **"Patient state evaluation"** is executed by therapist. Here doctor decides, whether clinic is able to perform treatment by its own or it is necessary to handover patient to a bigger state organization, which has ability and handle complex diseases. Another decision doctor can make is to discharge patient from the clinic as he was cured during treatment course or to discharge immediately, since no serious diseases were found during diagnostics.

**"Administration of handover to another medical organization"** process starts if necessary. Clinic takes care of patient and documents related to his treatment are handed over to partner state institution. **"Patient discharge"** process is executed by nurse and includes clinical record and all related to his treatment documents archiving for five years. Necessary documents such as copies of clinical record and protocols or statement of treatment may be issued to patient. After client is discharged he can choose whether to stay in touch with the clinic or not. If decision is positive, he is periodically monitored by administrators, who call him and asks about his condition. During monitoring client can ask for remove him from clinic's client database or he can agree on appointment initiating process **"Customer survey"**.

If none of these decisions are made and patient is neither handed over nor discharged yet, patient treatment is performed. Doctor evaluates patient state during the process **“Incapacity for work expertise”**. Depending on the incapacity period, doctor may handover that activity to a special commission, which is allowed by state and insurance companies to issue sick voucher for time longer than 30 days. If incapacity is serious, then commission evaluates possibility of issuing invalidity statement.

Then doctor assigns treatment to patient according to information obtained during diagnostics. Event “Diagnoses is ready” is a necessary condition for starting processes **“Treatment assignment”** and **“Medicines prescription”**. Here treatment plan and list of needed medicines and inventories is defined.

The last process is **“Treatments course”**, which is actual consumption of procedures and services. Process is finished after time, defined by therapist and patient is sent to repeated diagnostics and interview with his therapist.





Detailed model of the key process was changed by the author as the weakest part. Changed diagram is shown on figure 17. Here processes “**Medical tests**” and “**Doctor’s inspection**” are performed in parallel. Therefore, patient does not necessarily has to visit diagnosticians first. Parallelization should help stakeholders to spread customers equally among two processes. Patients will not accumulate in hallways for taking tests, but will be able to visit a therapist first and examined. During the inspection doctor should be able to assign more tests to save time in the future and get precise diagnoses earlier. During the process “**Patient state evaluation**” doctor can use results of medical tests and data from his interview to make a better decision on further steps.



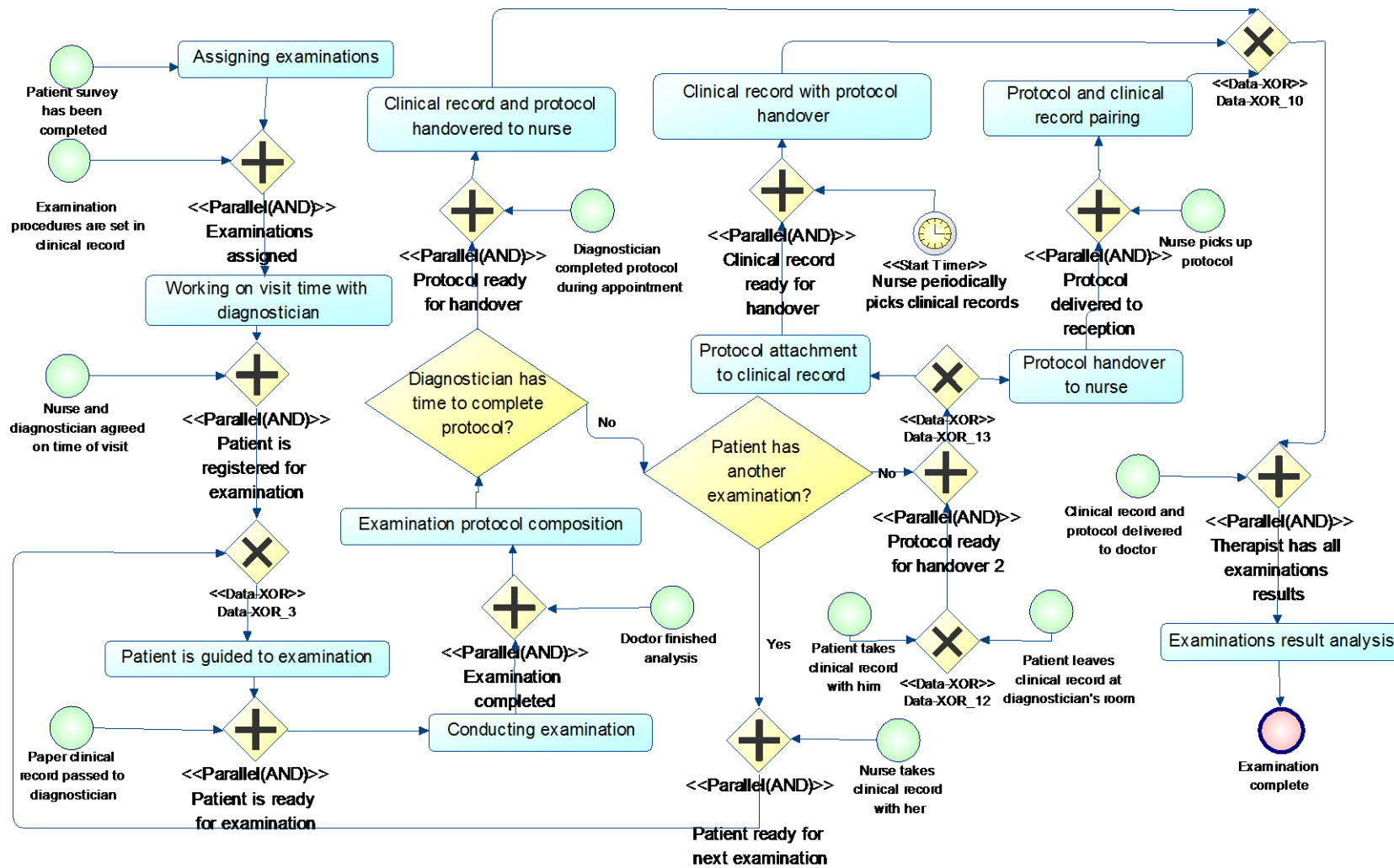


Figure 18. Organization of diagnostic tests. Source: Author

### 2.8.2.2 Organization of diagnostic tests

Business process “Organization of diagnostic tests” is shown in detailed view as an intention of looking for a way to increase efficiency of the given process. The detailed diagram on figure 18 generally describes activities performed by diagnosticians and nurses helping them with paperwork and work with patient. Besides those roles, also therapist is involved in the process as an internal customer, who evaluates outputs of patient examinations.

The trigger event for process **“Organization of diagnostic tests”** start is the moment, when initial survey is completed by administrator and general data about patient are collected. At this point a new clinical record is created for each patient in case patient has never visited the clinic before or an existing clinical record is updated. That means, that after administrator has finished the survey, he triggers process **“Examinations assignment”**.

During the process **“Examination assignment”** medical tests are assigned mostly by therapist during as a result of initial interview and information from the clinical record. In some cases, basic tests like blood test are assigned to patient by nurse or administrator at reception. All assignments are written down to paper clinical record. After all examination are assigned, there is need to cooperate with diagnosticians in order to arrange time for patient visit.

Process **“Working on visit time with diagnostician”** means arranging time for patient visit with diagnostician. Often is performed by nurse, but there are cases when doctor calls and arranges time himself. After nurse and diagnostician has agreed on time, patient is registered for examinations and he is guided to medical tests by nurse.

During process **“Patient guided to examination”** nurse, who is responsible for guiding patient to medical examinations and tests hands over clinical record to diagnostician. After that is done, patient is ready for survey at diagnostician’s workplace and process **“Conducting examination”** is triggered. After examination is done, doctor starts working on protocol, where tests results are submitted.

**“Examination protocol composition”** precedes further protocol handover. Protocol is created with the following two conditions (decisions: **“Diagnostician has time to complete protocol?”** and **“Patient has another examination?”**):

- a) If doctor has time and patient is not in hurry, protocol is composed during the visit and after together with clinical record it is passed to nurse (triggers process **“Clinical record and protocol handed over to nurse”**).
- b) In other case, if diagnostician cannot finish the protocol during appointment, then:
  - I. Event **“Patient leaves clinical record at diagnostician's room”** happens - if patient has no further appointments and diagnostics shortly after the first one, he leaves clinical record to diagnostician. Diagnostician completes the protocol and attaches it to clinical record himself (activity **“Protocol attachment to clinical record”**). Then several times a day nurse collects those documents triggering activity **“Clinical record with protocol handover”**.
  - II. Event **“Patient takes clinical record with him”** happens – if patient has no appointments, but he wishes to take clinical record with him, then the protocol is filled up without clinical record. In that case after nurse collects protocol she brings it to a reception and pairs with clinical record left by patient thereby she performs **“Protocol and clinical record pairing”** activities.
  - III. If patient has to go to another appointment, nurse takes his clinical record with her and when patient is ready, guides him to the next examination triggering activity **“Patient is guided to examination”** again until there are no further planned diagnostics.

After therapist receives all documents from nurses, process **“Examinations result analysis”** starts. Doctor goes through clinical records and medical tests analysis in order to write prescriptions for treatment or address patient to specialists if deeper analysis needed.

Clinical record is a primary legal document in diagnostic and treatment process of the clinic. As mentioned before, described sequence of activities is accompanied with

physical transportation of paper clinical record and given logistics is a complex process. Thus considerable amount of effort is being spent on monitoring that document location and safekeeping.

As shown on described process the fact of paper clinical record transportation is redundant and still resource-intensive task. Author does not take into consideration number of records made by each doctor and complexity of reading them by others. Nevertheless, time delays related to paper clinical record transportation are sufficient. At the same time, it should be noted, that paper work cannot be completely eliminated. Even with MIS utilization paper protocol with diagnostician's signature must be formed and attached to paper clinical record of the patient.

As a result of MIS introduction number of interacting roles cannot be decreased. But non-core activities of each role can be decreased significantly as well as time costs, which can needlessly prolong treatment process. On Figure 19 the same process is shown in context of the medical information system's support.

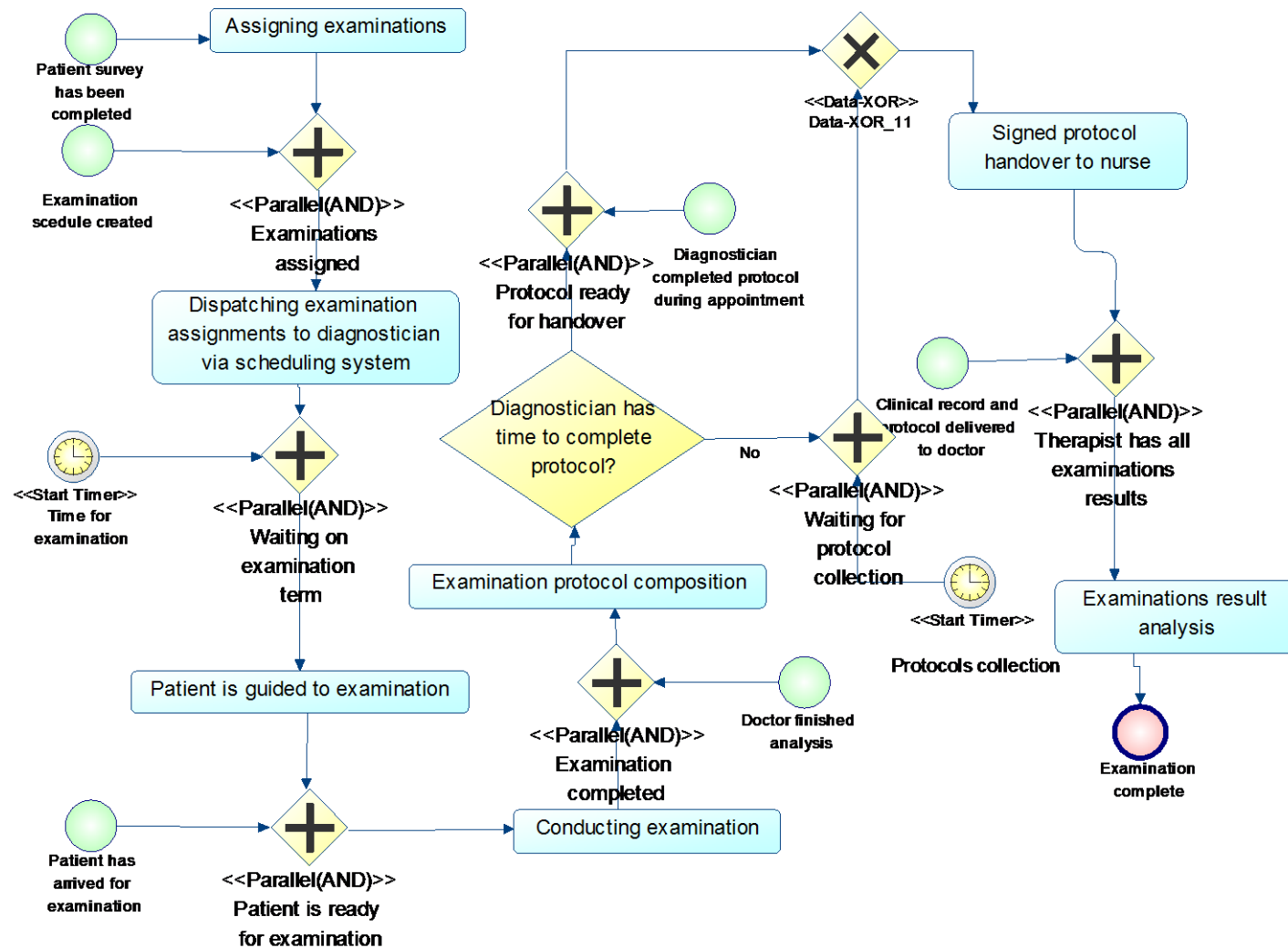


Figure 19. Recommendation for process Organization of diagnostic tests. Source: Author



In comparison to the initial detailed process activities mention below would be changed. Process **“Assigning examinations”** is executed electronically in MIS. After examinations assigned to patient, schedule is printed by administrator as an attachment to paper clinical record. Schedule creation by the administrator, triggers activity **“Dispatching examination assignments to diagnostician via scheduling system”**. As stated in its name, that activity executed by administrator or nurse allows diagnostician to see an appointment in his schedule when completed.

As in the previous version of the detailed model, activity **“Patient is guided to examination”** takes place on time assigned to patient. Diagnostician performs activity **“Conducting examination”** following patient arrival. Completing examination starts protocol results generation in electronic form with option of previewing full electronic patient clinical record. With author’s recommendations only one decision **“Diagnostician has time to complete protocol?”** follows. In that case:

- a) If diagnostician is able to complete protocol during an appointment, he fills up the document, prints and signs it.
- b) Otherwise protocol is created in electronic clinical record after patient has left, prints and signs.

In the first case after diagnostician finished conclusion, nurse collects signed document immediately, whereas after client has left signed protocols are being collected by diagnostician and his working place and nurse takes them to reception several times a day.

Process **“Examinations result analysis”** is triggered and executed by therapist after receiving notification on his workplace. MIS notifies him about new documents and doctor is able to see filled diagnostics results immediately after examinations have been completed. From that point he is able to plan further treatment or diagnostics.

Process description shows, that the main phases of given process remained unchanged, but essence of activities has changed in order to achieve their unification. Therapist’s dependency on timeliness of paper protocol receiving was completely removed. In

consequence of that change the role of courier nurse was executing has been eliminated as well. That means, that one of nurses does not have to handover protocols and paper clinical records to therapists anymore. In original process given activity could not be removed, since therapist would have to wait for diagnostics results for longer period of time if protocol is handed over occasionally. New form of clinical record allows to modify business process, since therapist receives outcomes of diagnostic right after they are created by other doctors despite the fact where and when paper protocol will be received. Presence of paper protocol in new process description is not excluded, but clinical hypothesis may be proposed by therapist already before receiving of paper documents, which formally approves that hypothesis.

Efficiency of introduced changes may be confirmed by calculating estimated expenses, eliminated by recommended process flow. For this purpose, main parameters of the process and stakeholder are defined in Table 3.

**Table 3. The average salary of the staff. Source: Author**

<b>Stakeholder (average)</b>	<b>Month salary, RUB</b>	<b>Hours per month</b>	<b>One hour cost, RUB</b>
<b>Therapist</b>	60 000	156	385
<b>Diagnostician</b>	60 000	156	385
<b>Nurse</b>	30 000	156	192
<b>Head Nurse</b>	45 000	156	288

**Table 4. Calculation of the cost of the task "Transport protocols to therapists". Source: Author**

<b>Task</b>	<b>Performer</b>	<b>Rate per hour, RUB</b>	<b>Number</b>	<b>Per day</b>		<b>Per month</b>		<b>Total, month</b>
				Hours	Rubles	Hours	Rubles	
<b>Transport protocols to therapists</b>	Nurses	192	4	1	192	22	4 224	16 896

Using average value of nurse time spending on clinical records transportation among doctors, nurse's absence one hour per day in average and number of nurses, involved in given process, it is possible to show, that for that single task half of middle-level employee's salary is spent on non-productive activity (Table 4).

List of activities, optimized in the same way may be extended due to:

- Reducing nurses' time spent on appointment agreement, which is replaced by automated dispatching. In that case nurses on both therapist and diagnostician sides save their working time.
- Reducing therapist waiting time on diagnostics results as well as decreased delay of decision-making on treatment assignment process, since therapist does not have to wait on paper protocol.

Next positive effect associated with the process changes is the fact that diagnostician does not have to manage paper logging of tests conducted during the diagnostic due to the automated logging based on created protocols. Rough calculations show that doctor, who serves 15 patients per day spends about 15 minutes on logging conducted examinations (60 seconds per one record). Assuming number of diagnosticians in the clinic increases to 15, then in one month the organization could save up to half of doctor's salary (Table 5).

**Table 5. Calculation of the cost of the task "Paper logging performed by diagnostician". Source: Author**

Task	Performer	Rate per hour, RUB	Number	Per day		Per month		Total, month
				Hours	Rubles	Hours	Rubles	
Paper logging	Diagnosticians	385	15	0,25	96,25	3,67	2 117,5	31 762,5

Calculations regarding head nurse and nurses, who prepare weekly, monthly, quarterly and annual reports spending about two hours per week show that given tasks cost one nurse monthly salary (Table 6).

**Table 6. Calculations of the cost of reporting tasks performed by nurses. Source: Author**

Task	Performer	Rate per hour, RUB	Number	Per day		Per month		Total, month
				Hours	Rubles	Hours	Rubles	
Weekly reports	Nurses	192	16	0,2	38	4,4	844	13 504
Monthly reports	Head nurse	288	1	1	288	22	6 336	6 336

In total, optimization of only one diagnostic business process due to electronic clinical record implementation might save clinic 68 498,5 rubles per month, which is sufficient in comparison to monthly wages-fund. Additional benefits like timeliness protocol receiving by therapists and other diagnosticians were not taken into account.



### **2.8.2.3 Personified record of material expenditures**

Model of personified record of direct material consumption in the clinic is shown on figure 20. Author's aim was to determine and describe one of typical business processes for designing healthcare organization information system. The main point of interest here is the detailed information about modelled objects, including analysis of existing documents, information flows and workplaces. Work on the model showed, that gathering comprehensive information on activities is a very demanding task, which forces to take a fresh look on regular activities. Process model is based on the following sources of information:

- Results of interviewing pharmacy employees, nurses on reception and head nurse of the clinic.
- Outcomes of normative documents analysis and study of internal rules regulating activities in the clinic.

During model preparation following normative acts and other documents regulating medical organization activities were analyzed:

- Federal law #134-FZ on placing orders for goods, operations and services for state and municipal needs
- Federal law #94-FZ on contract system in the procurement of goods, operations and services for state and municipal needs
- Russian Ministry of Health Order #80 on approval of the industry standard "Terms of sale and dispatching of medicines in pharmacy organizations. Basic provisions"
- Russian Ministry of Finance Order #173n on approval of forms of primary documents and accounting registers used by public authorities, local governments, National Academy of Sciences, state (municipal) institutions, and guidelines for their use.

Process roles are described in table 7. Roles naming may or may not be the same as employee's role in the organization. Furthermore, situations, when the same person executes several of described roles are possible.

**Table 7. Roles of personified record of material expenditures process stakeholders. Source: Author**

Number	Function	Function description
1	Head nurse	A member of the clinic responsible for interaction with the pharmacy.
2	Nurse on duty	Employee, that provides medical care to patients, and is responsible for interaction with doctors and head nurse.
3	Pharmacy	Structural unit of the business organization or organization carrying out its activity in the basis of the license for pharmaceutical activity, issued in established order.

The stimulus for starting process **“Personified record of material expenditures”** is the list of the present day procedures list forming. Then nurse performs activity **“Form list of needed inventory”** to ensure there will be no lack of materials and medicines for doctors' needs.

Nurse on reception, who is on duty for keeping medical chest ready for procedures checks if inventory meets current requirements. If so, materials and medicines used during the present day are periodically written off due to amortization. By constantly removing medicines for each patient treatment needs activity **“Inventory depreciation on individual patient”** executed and statement on material consumption is formed as an outcome of the process.

Availability of medicines and medical supplies needed for the execution of medical assignments and located on nurse's workplace is monitored and continuously checked.

Situation, when materials are missing triggers activity **“Form new inventory request”**. In case of shortage of specific medicines or medical materials, nurse should appeal to senior nurse for filling the lack of required inventory from the clinic’s medical chest.

Head nurse receives the request from her subordinates and conducts the monitoring of medicines and medical supplies. If she disposes inventory in clinic medical chest, then process **“Form statement of amortization”** is executed by head nurse, since it is necessary to write off inventory from head nurse evidence prior to handing over then to the reception.

If opposite event happens and both nurses cannot quickly get needed materials or medicines, process flow moves towards pharmacy side. Head nurse executes process **“Form inventory request to warehouse”**. In prescribed order she forms request and sends requirement to the warehouse (pharmacy) to replenish reserves of the clinic.

After request is sent by head nurse to the pharmacy, head of pharmacy, his deputy or person responsible for pharmacy unit initiates process **“Processing requirements”**. List of necessary inventory is evaluated and pharmacy workers decide if request contains valid items and fulfillment of given requirements is possible. If request is invalid it is sent to head nurse for altering during **“Sending request back”**. After head nurse is acquainted with denial, she could change requirements and rework process **“Form new inventory request”**.

In case of a valid request pharmacy checks availability of given items in the list. Process **“Availability check”** is one of the most time-consuming processes as even a small pharmacy might store hundreds of different medicines and materials. Unavailable for ordering items from third-party companies is triggered in case if they are also not present in the warehouse. Depending on a decision **“Are items ordered?”** process flow either finishes or proceeds further.

There might be the cases, that patients, thus nurses and doctors, cannot wait for ordered items to arrive in order to meet all of the requirements. In that case, partial consignment might be sent by pharmacy. To prevent unnecessary waiting for full or partial consignment, process **“Form invoice for issuing inventory from warehouse”** is ran in



parallel with consignment completion and physical sending. After pharmacy is done with supplies preparation with required materials, head nurse physically receives and controls the consignment. She performs **“Forming statement of amortization”** and writes an act of amortization prior to physical **“Issuing of inventory to nurse”**.

After that nurse on reception follows the same procedure as she would follow in case of all inventory would be available in the beginning of the process. Based on marks done during the day in abovementioned list of procedures she creates personified invoice on material consumption on patients. In the process of invoice creation nurses use material consumption standards database. Consumption, which is not ascribed to patients is written off in act of material amortization and is depreciated.

## **2.9 Information System Functionality**

Functions taking place in the information system must support real business functions of the organization. The author proposed a functional model system using DFD diagram. On figure 21 is represented data flow diagram composed referring to class diagram and global process diagram. It is a representation of suitable information system functions for chosen medical organization. Diagram represents data flows between Data Stores, Processes and External Entities.

This diagram consists of nine processes which should be supported by information system. After new client comes, “Registration” process is needed. Inside this process client’s profile is created. Data collection about client disease history, allergies and other important information for future treatment and examination is performed.

In “Client survey” process clinical record is created based on all collected data from previous process. It is the main document about client, which contains all prescriptions and illness history of a client.

When all information about client is collected and clinical record is ready, client should go through medicine tests, doctor inspection and consultation with specialist if

necessary. All these activities are combined in “Patient examinations” process. Diagnosis is an output from this process.

“Employee administration” is process supported by clinic’s management and administrators. Inside of this process interviews, employee trainings and employee data collections are performed. Data about doctors are the main output flow in this process, based on them selected doctors could be assigned for particular client treatment.

“Items managing” represents complete material management. It is the main process between pharmacy and supplier. Material orders processing and receiving, managing warehouse and the best supplier selection for particular material order activities are combined inside that process.

“Treatment assignment” is a treatment plan creation with references to client’s diagnosis. The most suitable treatment course is selected during that process.

“Patient treatment” process deals with treatment delivery. Planned treatment procedures are realized at this process. Receiving needed material from pharmacy and complete medical care, based on treatment plan, is executed.

Following process is “Patient discharge”. This process evaluates results of “Patient treatment” process. The doctor may prescribe some medicaments and fill clinical record.

The last process described here is “Invoicing”. Main goal of this process is to create an invoice with all procedures client received during treatment as well as tracking of materials spent on patient treatment. Also this process combines transferring of invoice to client and payment receiving.

As external entities “Employee”, “Client”, “Supplier” and “Pharmacy” are shown. Information system should support external influences of chosen entities.



## **2.10 Medical Information system**

Modern medicine is impossible to imagine without use of information technologies. Their use allows to improve quality of medical services e.g. to simplify doctor's appointment scheduling, expedite the filling of medical records, ensure the provision of specialized medical care and to solve many other issues, that directly faces every patient, who comes for an appointment to any medical organization.

That is why on the agenda of described medical organization stays the problem of choosing and implementing suitable medical information system presented on the market, which allows to store, process data and conduct patient records in electronical form, supports the most important business processes in the clinic. Presence of great offer on the software market of medical information systems rises the problem of choice.

The software market is very diverse, so the difficulty of choosing a particular system by medical organization caused due to objective reasons. There are expensive systems as well as economy class solutions. There are highly specialized and very narrowly focused systems as well as "builders", which are configurable systems allowing users to implement their own requirements. All variety on the market comes from the fact that the same functional requirements are implemented in different ways. And from the product name and brief description is impossible to determine its functional completeness. Due to the lack of objective criteria and generally accepted methodologies for assessing the quality of medical information systems and their compliance with the real needs of healthcare organizations (customers or users), the risk of acquiring "not the one" systems in terms of compliance with the functional tasks of particular medical institution and requirements laid down in the law arises.

Medical information system (MIS) designed for informatization of business processes of medical institution, in general, is an integrated and functional environment, that combines elements of different types of medical systems. Typical modern MIS groups and provides support for the following informational resources [SANNIKOV, 2009]:

- Electronic clinical records of patients
- Results of laboratory tests
- Financial and economic information
- Database of medicines
- Database of materials
- Database of workforce
- Expert systems
- Diagnostic and treatment standards

The most known classification of MIS in Russia belongs to [GASPARYAN, 2007], who has divided medical information systems into following six groups: technological, resource, statistical and analytical, scientific, educational and referential systems. According to [XAI, 2001], medical systems are structured as following types: technological, referential, databases, instrumental or measuring and computational, service, automated and image processing and transmitting. Nevertheless, one of indisputable classifications of MIS used in Russia is classification based on hierarchical principle, which is compliant to a health care systems' structure. Typical levels are:

- Base (clinics)
- Institutions (clinics, hospitals, dispensaries)
- Territorial (specialized medical centers, regional health authorities)
- Federal (federal agencies and healthcare departments)

Within each level Medical IS are classified based on goals and objectives they designed to solve. As described clinic is a small organization, the medical information system

type cannot be on territorial or federal level due to their complexity, unnecessary functionality and thus high prices. Therefore, further discussion concentrates on first two levels.

### **2.10.1 Basic level of MIS**

Basic MIS are intended to support technological processes. Systems of that type are designed to provide information for decision-making in professional activities of doctors. They allow improving quality of preventive, diagnostic and therapeutic work, especially in context of lack of time during mass service and qualified specialists.

Depending on problems that systems solve, they may be divided into the following groups:

1. Medical information and referral systems - they are designed to search and display medical information on user's request. They include medical reference information of various kinds. The need to accumulate large amounts of valuable professional information and to operate with it is one of the problems, which doctors face. Given software facilitate the solution of this problem acting as secure storage of professional knowledge and providing convenient and fast search of required information. System of that kind do not process any information.
2. Medical consultation and diagnostic systems - that kind of systems is designed for the diagnosis of pathological conditions (including forecasts and generating recommendations on treatment options) based on intellectual (expert) approach. Diagnostic systems are intended to support one of the main activities in healthcare – doctors job, which is based on making diagnostic and therapeutic decisions.

Since decision making is a result of processing of certain amount of information about the patient and is based on utilization of accumulated knowledge, artificial intelligence systems and expert systems in particular are developed in order to help doctors solve problems of diagnostics and choose right approach during treatment.

Knowledge base of such systems is based on approach of “IF-THEN” rules. Expert system contains expert knowledge presented by given rules and is able to provide advices and develop solutions on tasks, which are normally solved by domain experts. Expert systems are applied in highly specialized tasks, for which no clearly formulated solution exists. These tasks are vague and usually solved in conditions of high uncertainty. Many information processing and expert analysis systems are build based on that principle. Based on medical tests results and clinical observation these systems are able to provide users with qualified opinion for each case and develop an optimal strategy of treating patients in short period of time.

3. Medical instrumentation systems are designed in order to provide information support and diagnostic and therapeutic processes automation, carried out by direct contact of sensors with human body e.g. during registration of physiological parameters.
4. Automated doctor workplace is set of equipment and software, located directly on a specialists’ workplace. Given information system designed for automation of the whole technological process of medical specialist and provide information support during the whole process of making diagnostic, therapeutic and organizational decisions [SANNIKOV, 2009].

All types of information systems mentioned above may be embedded into the structure of automated workplace providing automation of the entire process health professional involved. Integrated system then includes medical prevention, reporting and statistical activities, documentation management, getting all sorts of valuable information.

Basic automated workplaces are divided into two groups: workplace for doctors and workplace for administrative units of the organization. In addition to the general requirements to the system (e.g. minimal response time,

adaptation to set of functions user performs, ease of maintenance, ability to work in a computer network etc.) more needs are relevant in case of automated workplace for physician. In particular, automated doctor workplace should be able to perform the following tasks: maintaining formalized clinical record of patient, which is able to show state dynamics; providing recommendations on the planned examination of the patient; storing decisions made on treatment methods; creating epicrisis, reporting and statistical documentation, treatment services costs calculation.

On the other hand, administrative workstations are intended for automation of administration, management, financial and economic activities of health facilities. They make it possible to monitor medical staff activities, treatment deadlines, financial and economic indicators, keep track of resources and clearing-offs with insurance companies etc.

### **2.10.2 Institutional level of MIS**

Traditional management system of health care organization, which did not adapt information technologies, has number of disadvantages such as lack of timelines in obtaining the necessary information, need of additional calculations for obtaining indicators, impossibility to analyze indicators of health facility performance. Medical Information systems on the level of whole medical organization allow to combine all information flows into one system and to automate various types of activities of the organization. Consequently, information system is developed as integrated set of tools to automate collection, storage, processing and presentation information on patients, medical and technological processes in diagnosis and treatment, planning and analyzing activities of the clinic in order to optimize their performance. Existence of such MIS in the clinic is not possible without implementation of diagnostic testing automation, automated workstations for doctors and administrators since they serve as information resources for the uniting system of the second level.



Central area of informatization of medical organization is focused on creation and implementation of the integrated systems. Among the main tasks to solve next should be highlighted:

- Administration, management (including record of patients, staff, medicines and tools), financial tasks and problem of clinic development
- Patient care tasks including clinical record management: applications for medical tests and treatment sheet management, handover of the results from the laboratories and other departments; registration of orders for medicines, patient dietary food planning, providing consultation and reference information. Besides that, staff work scheduling is also related to medical patient care tasks.

Sequence of main functions for management is constructed as follows: planning, organization, leadership, control. Management activities based on planning can be presented as a process consisting of four coherent steps: planning, plan implementation, monitoring and control of the results, where Medical IS represents a core of given management cycle. That core supports management by providing analytical information.

### **2.10.3 MIS selection criteria**

MIS is treated as a tool for ensuring the implementation of effective administrative decisions in the clinic, the transparency of medical and financial flows, reliable statistics, automation of routine in medical documentation management. MIS is multifunctional tool, which covers the majority of material, administrative, financial and treatment business processes. In addition to that, clinics tend to install electronic equipment, which implies MIS integration. Almost all medical and non-medical staff of the organization is involved in the interaction with MIS. That interaction is intended to ensure economic efficiency of the healthcare clinic. Process for MIS selection should focus on Russian systems, as management system has its own features and properties, which are not implemented in foreign systems.

When comes to comparison of different systems aiming to choose the best, tables with different MIS products with hundreds of hardly comparable technical characteristics, it is hard

to decide, which of them are important and which can be neglected. Comparison of developers' prices is complicated as well, since they mostly provide license costs omitting infrastructure costs, which may vary for different systems' requirements. Another reason for not doing that is the fact, that Russian market is highly competitive and the differences of license prices are not big. To help clinic managers engaged and responsible for MIS implementation avoid mistakes during the process of MIS selection author suggests eight main criteria, which can be compared among MIS and get the right evaluation. Significance of each criterion may vary for specific clinic.

1. Source of data. Management should decide what source of data is used for the system: medical documentation or statistics. Medical data can be collected from the primary sources (clinical record). Statistical data are collected from secondary, statistical documents (tickets to doctor). In the first case system may become a full MIS in the future, but relying on secondary data cannot guarantee complex automatization of processes and bring advantages of functional MIS supporting business processes. Relying on the statistical data does not change the way how medical organization has been working before system implementation. Moreover, process of employees doing non-productive activities by explicitly entering data to the system appears.
2. MIS should contain domain reference in form of complete and structured electronic document. In most of MIS those documents are presented by presented by references, classifiers linked with each other. If given references provide only statistical processing of data, the solution, as well as in case of the first criteria, cannot be considered as complex MIS. References and classifiers supporting medical activities (localization and description of disease and nosology, links between those entities) most probably are able to solve more complex tasks. For instance, MIS can realize dialog with doctor during forming of prescriptions, medical tests and diagnoses. References presence does not mean, that full automation of doctor's activity is possible as expert systems and references do not

replace professional knowledge and skills. Interaction between doctor and the system should be simple, comfortable and effective.

3. Functional customization. While choosing MIS, customer should figure out and clarify with the supplier if the system settings could be changed without code recompilation. Supplier has to demonstrate ability of the system to adapt to customer's needs in the future only by system customization through administrator interface. Possibility of customization should be available for different components of the system. For instance, customization of input fields, which are used in daily work by doctor, documents and reports, structure of stored data customization. Functional scalability is not widely spread among suppliers as it demands big investments during MIS development. That means, that products, developed on basis of one or several medical organizations may not be suitable for others and are less customizable than systems developed by independent suppliers with many customers.
4. Scalability is highly connected to the previous criterion. Scalability as ability of adaptation of the system to clinic's requirements during its expansion. Expansion may be presented either by new services and units introduction or geographical expansion by opening new offices. Also, scalability assures support of quantitative growth of users or structural units.
5. Ability of equipment connection. That means system should support open protocols as DICOM and HL7. MIS with integrated support of given standards allows to integrate any DICOM-compatible medical equipment. If integration is available, MIS users can handle any images, imported from diagnostic equipment from one single application, as objects in electronic medical record of the patient. International HL7 integration allows integration with other systems in order of clinical or administrative information exchange. Lack of that features forces users to handle multiple applications, leads to redundancy and lack of information about patient.

6. Important factor in selection process can become ability of supplier to provide technical support to their product online. That support should be available in typical working hours, which becomes highly important, due to multiple time zones in Russia. Thus, ideal solution is 24 hours support. Big medical facilities can solve technical support issues by involving their own IT staff into partial support of the system.
7. License costs. Often, one of the most common parameters of system cost is license per one workplace. That cost depends on abovementioned features of the system. The second factor of MIS cost are implementation costs. That is a very complex indicator, which reflects hidden components: qualification of implementation specialists, functionality and adaptability, solution's prestige on the market.
8. Integration and standardization possibilities. From strategical point of view manager may bear in mind possibility of system replacement in the future as well as integration with information systems of suppliers. Criterion is called strategical as nowadays most of the systems on the market either don't support such integrations or support it only partly.

Author has analyzed eight most important criteria, which may be useful for managers of medical facilities in the process of selection a tool, which supports business processes. The right choice in long term may become a factor of clinic's grow. And at the same time, mistake may become crucial and lead to financial, organizational and psychological consequences. Complex MIS is merging into company's business processes. Thus it is very important to deeply analyze all MIS offers on the market and make a reasonable decision.

## **Conclusion**

The diploma thesis was dedicated to create basics for process engineering implementation in chosen medical organization.

The goal of first chapter was to describe a methodological basics. Methodological basics combine all theoretical definitions, concepts and procedures, in order to select the most suitable methods for implementation in real organization. Author's finding was, that processes their relations and detailed definitions are the basis for process-driven organization. Detailed explanation and description of processes are essential for company employees to work on building a process-driven organization. Advantages of process-driven organization motivated author to analyze and try to change current situation of the chosen company.

Goal of the practical part was to map existing processes in the company. Weak places were found shortly. Improvement recommendations followed the analysis in order to rise company prestige in eyes of customers and to avoid delays and unnecessary non-productive activities executed by employees during their daily work. Moreover, author proposed improvement examples and calculated its benefit. Company organizational structure was described and followed by SWOT-analysis, which showed up the weakest parts of the organization's existence. Table with objectives followed by SWOT analysis, where exact milestone for their achievement were proposed as an outcome of management interviews. Company's system modelling was executed using MMABP methodology.

The last chapter was intended to describe typical levels and attributes of medical information systems in Russian Federation, since wester systems are compatible with Russian management processes and habits. Author also proposed criteria for MIS selection by management in order to guide them through the typical problems and help to prepare for analysis.

To summarize, the thesis deals with the main objective – the basis for introduction to process management was achieved. Management of the clinic has ensured author, that they

want to fully implement proposed solutions and to keep moving towards that goal with their business processes supported by complex medical information system.

## Bibliography

- ASHIHMIN Yaroslav. Optimizacija raboty chastnoj kliniki v usloviyah stabilnoj ekonomicheskoy situacii.: Perspektivi na 2015- 2016 god. Chast *MEDESK* [online]. 2015 [cit. 2016-04-20]. Available from: <http://www.medesk.md/ru/blog/2015-06-15-forecast-2016-part-2/>.
- BRUCKNER, Tomáš, Jiří VOŘÍŠEK, Alena BUCHALCEVOVÁ, Iva TANOVSKÁ, Dušan CHLAPEK a Václav ŘEPA. *Tvorba informačních systémů: principy, metodiky, architektury*. První vydání. Praha: Grada Publishing, 2012. Management v informační společnosti. ISBN 978-80-247-4153-6.
- CIENCIALA, Jiří. *Procesně řízená organizace: tvorba, rozvoj a měřitelnost procesů*. 1. vyd. Praha: Professional Publishing, 2011. ISBN 978-80-7431-044-7.
- DAVENPORT, Thomas H. *Process innovation: reengineering work through information technology*. Harvard Business Press, 2013.
- ERIKSSON, Hans-Erik and Magnus PENKER. *Business modeling with UML: business patterns at work*. New York: John Wiley & Sons, c2000. ISBN 0-471-29551-5.
- Federalnii zakon ot 21 iulya 2005 g. N 94 – FZ “O razmeshenii zakazov na postavki tovarov , vpolnenie rabot, okazanie uslug dlya gosudarstvennih I municipalnih nuzhd”. *Sobranie zakonodatelstva Rossiiskoi Federatsii*, 2005.
- Federalnii zakon ot 5 aprelya 2013 g. N 44 – FZ “O kontraktной sisteme v sfere zakupok tovarov, rabot, uslug dlya obespecheniya gosudarstvennih I municipalnih nuzhd”. *Sobranie zakonodatelstva Rossiiskoi Federatsii*, 2013.
- GASPARYAN S. A. *Mediko- socialny monitoring v upravlenii zdavoohraneniem*. Moskva: Forsikon, 2007. ISBN 978-5-9900544-7-9

- GUDOV A. H., POLYAKOV S. V., KAMENSKY V. A., CHIGRINEZ O. V. Swot-analiz deyatelnosti medicinskoy organizatsii v aspekte konkurentosposobnosti uslug. *Vestnik Roszdravonadzora* [online]. 2012. N1. [cit. 2016-03-21] Available from: <http://cyberleninka.ru/article/n/swot-analiz-deyatelnosti-meditsinskoy-organizatsii-v-aspekte-konkurentosposobnosti-uslug>
- GULIEV Y. I., GULIEVA I. F., RYUMINA E. V., MALYCH V. L., FOCHT O. A., TAVLYBAEV E. F., VAHRINA A. Y.. Podhod k ocenke ekonomicheskoy effektivnosti medicinskih informacionnih system. *Manager Zdravooohraneniya* [online]. 2013. N4. [cit. 2016-04-01]. Available from: <http://cyberleninka.ru/article/n/podhod-k-otsenke-ekonomicheskoy-effektivnosti-meditsinskih-informatsionnyh-sistem>.
- GULIEVA I. F., RYUMINA E. V., GULIEV Y. I.. Voprosy effektivnosti informacionnih tehnologiy v medicine. *Manager zdravooohraneniya* [online]. 2011.N10. URL: . [cit. 2016-04-01]. Available from: <http://cyberleninka.ru/article/n/voprosy-effektivnosti-informatsionnyh-tehnologiy-v-meditsine>
- HAMMER, Michael, and James CHAMPY. *Reengineering the Corporation: Manifesto for Business Revolution*, A. Zondervan, 2009.
- HAMMER, Michael. "The process enterprise: An Executive perspective." *Hammer and Company* 1, no. 0 (2001).
- KABRINSKIY B. A., ZARUBINA T. V. *Medicinskaya informatika*. Moskva: Centr Akademiya, 2009.
- MMABP v2.0: Methodology for Modelling and Analysis of Business Processes. *Opensoul* [online]. 2011 [cit. 2016-04-14]. Available from: [http://mmabp.panrepa.org/MMABP\\_map.html](http://mmabp.panrepa.org/MMABP_map.html)
- OMG. Business Process Model and Notation (BPMN) [online]. [cit. 2016-03-21]. Available from: <http://www.omg.org/spec/BPMN/2.0/PDF>.
- ORLOVA, Y and Marina MISHCHENKO. *Razrabotka biznes- plana sozdanija stomatologicheskoy kliniki*[online]. Institute technology and of business Of



Nakhodka, Russia, 2014, 82 [cit. 2016-04-20]. Available from: <http://www.scienceforum.ru/2014/pdf/771.pdf>

- PALL, Gabriel A. *The process-centered enterprise: the power of commitments*. Boca Raton: St. Lucie Press, c2000. ISBN 1574442392.
- Prikaz Minzdrava Rossiiskoi Federatsii ot 15 dekabrya 2010 g. N173 –n. “Ob utverzhdenii form pervichnih uchetnih dokumentov I registrov buhgalterskogo ucheta, primenyaemih organami gosudarstvennoy vlasti (gosudarstvennimi organami), organami mestnogo samoupravleniya, organami upravleniya gosudarstvennimi vnebudzhetnimi fondami, gosudarstvennimi akademiyami nauk, gosudarstvennimi (municipalnymi) ucherezhdeniyami, i metodicheskikh ukazaniy po ih primineniyu”. *Sobranie zakonodatelstva Rossiiskoi Federatsii*, 2010.
- Prikaz Minzdrava Rossiiskoi Federatsii ot 28 aprelya 2011 g. N164 . “Ob utverzhdenii koncepcii sozdaniya inforacionnoi sistemi zdravooohraneniya”. *Sobranie zakonodatelstva Rossiiskoi Federatsii*, 2011.
- Prikaz Minzdrava Rossiiskoi Federatsii ot 4 marta 2003 g. N80 . “Ob utverzhdenii otraslevogo standarta pravila otpuska (realizacii) lekarstvennih sredstv v aptechnih organizaciyah. Osnovnie polozheniya”. *Sobranie zakonodatelstva Rossiiskoi Federatsii*, 2011.
- PROCHÁZKA, Jaroslav. *Procesní řízení realizace projektů*. Ostrava: Ostravská univerzita [online], 2006. [cit. 2016-04-12]. Available from: [http://www1.osu.cz/~prochazka/rpri/skripta\\_ProcesniRizeniProjektu.pdf](http://www1.osu.cz/~prochazka/rpri/skripta_ProcesniRizeniProjektu.pdf)
- ŘEPA, Václav. *Podnikové procesy: procesní řízení a modelování*. 2., aktualiz. a rozš. vyd. Praha: Grada, 2007. Management v informační společnosti. ISBN 978-80-247-2252-8.
- ŘEPA, Václav. *Procesně řízená organizace*. 1. vyd. Praha: Grada Publishing, 2012. Management v informační společnosti. ISBN 978-80-247-4128-4.

- UML 2 Class Diagrams: An Agile Introduction. *Agile Modeling* [online]. [cit. 2016-04-20]. Available from: <http://www.agilemodeling.com/artifacts/classDiagram.htm>
- WHITTEN, Jeffrey L., Lonnie D. BENTLEY and Kevin C. DITTMAN. *Systems analysis and design methods*. 4th ed. Boston, Mass.: Irwin/McGraw-Hill, c1998. ISBN 025623826X.
- Work as a process. *Winsconsin Hospital Accosiation: Quality Center* [online]. [cit. 2016-02-26]. Available from: <http://www.waqualitycenter.org/Portals/0/Tools%20to%20Use/Understanding%20Process/Work%20as%20a%20Process%20R%202-12.pdf>
- XAI G. A. Kompyuternaya podderzhka raboty vracha. *Informacionnie technologii v zdravoohranenii*, N 10-12, 2001, s. 10-11.

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