Ministry of Science and Higher Education of the Russian Federation
National Research Tomsk Polytechnic University

Research School of Chemistry & Applied Biomedical Sciences
Biomedical Sciences and Engineering

УДК: 338.46:614.21:658.18(571.16)

Master Thesis

Title
Study of factors affecting the quality of medical care (for example, organizations of Tomsk region, participating in the project "Lean Polyclinic") Исследование факторов, влияющих на качество оказания медицинской помощи (на примере организаций Томской области, участвующих в проекте «Бережливая поликлиника»)

Student

Group	Name	Signature	Date
1ДМ7И	Natalia V. Kopysova		

Scientific Advisor

Position	Name	Degree	Signature	Date
Full Professor	Konstantin S. Brazovsky	PhD		

Scientific Consultant

Position	Name	Degree	Signature	Date
Associate Professor	Alexander A. Solovyev	PhD		

Consultants

of chapter Financial management, resource efficiency and resource saving

Position	Name	Degree	Signature	Date
Senior Lecturer	Nina V. Potekhina			

of chapter Social Responsibility

Position	Name	Degree	Signature	Date
Associate Professor	Mikhail V. Gorbenko	PhD		

Admit Thesis for Defense

Position	Name	Degree	Signature	Date
Master program supervisor	Fedor A. Gubarev	PhD		
Head of R.S.C.H.B.	MekhmanS. Yusubov	Doctor of Science		

Tomsk – 2019

Планируемые результаты освоения

Код	Результат обучения
Общепрофессиональные компетенции	
Р1	Ставить и решать задачи комплексного инженерного анализа и синтеза с использованием базовых и специальных знаний, современных аналитических методов и моделей
Р2	Внедрять, эксплуатировать и обслуживать современное электронное медицинское оборудование, обеспечивать его высокую эффективность, соблюдать правила охраны здоровья и безопасности труда, выполнять требования по защите окружающей среды
Р3	Использовать базовые и специальные знания в области проектного менеджмента для ведения инновационной инженерной деятельности с учетом юридических аспектов защиты интеллектуальной собственности
Р4	Активно владеть иностранным языком на уровне, позволяющем работать в иноязычной среде, разрабатывать документацию, презентовать и защищать результаты инновационной инженерной деятельности
Р5	Эффективно работать индивидуально и в качестве члена команды, проявлять навыки руководства группой исполнителей, состоящей из специалистов различных направлений и квалификаций, с делением ответственности и полномочий при решении комплексных инженерных задач
Р6	Способность к активному общению с коллегами в научной, производственной и социально-общественной сферах деятельности, готовностью оформлять, представлять, докладывать и аргументированно защищать результаты выполненной работы
Р7	Проявлять способность к самообучению и непрерывно повышать квалификацию в течение всего периода профессиональной деятельности
Р8	Осуществлять педагогическую деятельность в области профессиональной подготовки
Профиль Биомедицинская инженерия	
Р9	Применять глубокие инженерные и научные знания в области разработки, эксплуатации, обслуживания и ремонта современной высокоэффективной электронной медицинской техники
Р10	Применять глубокие инженерные и научные знания в области разработки, эксплуатации, обслуживания и ремонта современных медицинских информационно-диагностических систем
Р11	Выбирать и использовать на основе базовых и специальных знаний необходимое оборудование, инструменты и технологии для проведения исследований в сфере биотехнических систем и технологий с учетом экономических, экологических, социальных и иных ограничений
Р12	Проводить теоретические и экспериментальные исследования в области разработки новых биотехнических систем медицинского назначения, включая поиск необходимой информации, эксперимент, анализ и интерпретацию данных с применением базовых и специальных знаний и современных методов для достижения требуемых результатов

APPROVED:

Head of the School of Chemistry & Master program supervisor

_____Mekhman S.Yusubov

TASK

Form

Master Thesis

Student

Group	Name
1ДМ7И	Natalia V. Kopysova

R&D

Study of factors affecting the quality of medical care (for example, organizations of Tomsk region, participating in the project "Lean Polyclinic")

Director approval order	
Date of Submission	

Basic Information	Actual questionnaires used by organizations to value the quality of medical service. Kribrum as a method to gather the information
Content	1. Abstract 2. Introduction 3. Literature review 4. Experimental algorithm 5. Social responsibility 6. Financial management and resources efficiency 7. Conclusion
Assigned Date	11/11/2017

The task was issued by

Position	Name	Degree	Signature
Full Professor	Konstantin S. Brazovsky	PhD	

Abstract

Keywords: lean polyclinic, quality, degree of satisfaction, patient satisfaction, data processing

The object of this study is a patient satisfaction. It is an important and commonly used indicator for measuring the quality in health care. Patient satisfaction affects clinical outcomes, patient retention, and medical malpractice claims. It affects the timely, efficient, and patient-centered delivery of quality health care.

This paper presents the method to use the data processing algorithm to study the factors affecting the quality of medical care.

The purpose of the study is to propose a new method to analyze the state of satisfaction of the population in the provision of medical services and observe the changes taking place in this area in connection with the start of the national project "Lean polyclinic" (LP).

The material of the study was the responses on paper of the interviewed patients and the comments in the internet.

Results: a new method to gather the information about the patient satisfaction to ensure the improvement of the quality of services and the improvement of the organization of work of medical personnel was presented.

Conclusion: the present study established that the use of lean production technologies contributes to the quality of medical services and it has a beneficial effect on the processes of organization of work of medical institutions.

Table of contents

Introduction

The quality of medical services is considered as one of the important results of the state social policy at all its levels. In the light of the problems of reforming the health care system of the Russian Federation, research on the quality of medical services is becoming ever more relevant, and its reform is aimed to increase the quality.

The goal of any control in its classical sense should be not so much the identification of violations (defects) as the analysis of whether the process of achieving one or another goal is properly implemented with the subsequent development of corrective action measures.

This practice is worldwide used. For example in USA there is a special agency to work with it. The Agency for Healthcare Research and Quality's (AHRQ) mission is to produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable, and to work within the U.S. Department of Health and Human Services and with other partners to make sure that the evidence is understood and used.

In our work, we will focus on assessing patient satisfaction with the quality of medical services based on big data analysis.

Brief description of the problem:

At present, there is no adequate system for assessing patient satisfaction with the quality of medical services provided in the organizations of the Mandatory Medical System in the Tomsk Region. There is a need for a system that would allow obtaining a relevant assessment of the actual state of the service model in medical organizations in the Tomsk region. At the present time, the evaluation system is based on the physical questioning of patients according to the approved form of the questionnaire. The problem is in its low coverage and as a result there is no real picture.

Formulation of the problem:

It is necessary to build a system for assessing the quality of medical services based on the analysis of feedback data from social networks and specialized Internet resources.

Expected result:

An independent assessment tool for medical organizations that allows you to get a realistic assessment of the patient's satisfaction with the quality of medical services provided based on user reviews in social networks.

Possible sources of data: all types of social media and the press: social networks, blogs, forums, thematic portals, microblogs, online media, video hosting, radio, television and creeping on TV, print media, news agencies.

1 Literature review of existing methods to observe patient satisfaction with medical service

In this chapter we will see what systems are functioning in Russia and other countries.

Patient satisfaction is under great attention not only in Russia, but **in USA** as well.

The Agency for Healthcare Research and Quality's (AHRQ) mission is to produce evidence to make health care safer, higher quality, more accessible, equitable, and affordable, and to work within the U.S. Department of Health and Human Services and with other partners to make sure that the evidence is understood and used. The Agency has got different types of surveys to get the patient satisfaction with medical service. Some of them are presented below.

Consumer Assessment of Healthcare Providers and Systems (CAHPS) is an AHRQ program that began in 1995. Its purpose is to advance our scientific understanding of patient experience with health care. The acronym "CAHPS" is a registered trademark of the Agency for Healthcare Research and Quality (AHRQ).

Brief History

AHRQ first launched the CAHPS program in October 1995 in response to concerns about the lack of good information about the quality of health plans from the enrollees' perspective. At that time, numerous public and private organizations collected information on enrollee and patient satisfaction, but those surveys varied from sponsor to sponsor, often changed from year to year, and did not provide actionable information on what actually happened during the delivery of care (i.e., the experience of care).

Over time, the program has expanded beyond its original focus on health plans to address a range of health care services and settings to meet the various needs of health care consumers, purchasers, health plans, providers, and policymakers. The CAHPS program is currently in its fifth stage, referred to as CAHPS V, which continues the work of earlier CAHPS grants (I-IV). The CAHPS V program also

encompasses research to further understanding of patients' experiences with patient safety, care coordination, shared decisionmaking, and patient engagement.

The CAHPS Hospital Survey (often referred to as HCAHPS or Hospital CAHPS) asks people to report on their recent experiences with inpatient care. There are two versions of this survey: one for adults and one for children. Both versions of the survey focus on aspects of hospital care that are important to patients. They also ask respondents to rate the hospital and indicate their willingness to recommend the hospital. The National Quality Forum has endorsed the CAHPS Hospital Survey as a measure of hospital quality.

Adult HCAHPS

The Adult Hospital Survey is a standardized questionnaire for people 18 and older who have been inpatients in medical, surgical, or obstetric departments. The Centers for Medicare & Medicaid Services (CMS) is responsible for the implementation of this survey and uses it for both public reporting as well as value-based purchasing. As a result, the survey and all supporting documentation for survey administration are available from CMS at www.hcahpsonline.org Link to Exit Disclaimer; no documentation for this survey can be found on this Web site.

Child HCAHPS

The Child Hospital Survey is a standardized questionnaire for parents/guardians of children 17 and younger who have been inpatients. The Child version asks parents to report on both their child's inpatient experience and their own experience with their child's inpatient stay. In contrast to the Adult Hospital Survey, which is implemented by CMS, the Child Hospital Survey is fully supported by AHRQ's CAHPS User Network.

The CAHPS Outpatient and Ambulatory Surgery Survey (OAS CAHPS) is designed to assess the experiences of adult patients who receive care in Medicare-certified hospital outpatient surgery departments (HOPDs) and ambulatory surgery centers (ASCs). The Centers for Medicare & Medicaid Services implemented a voluntary national reporting program with this survey in early 2016.

The CAHPS American Indian Survey is a standardized questionnaire that asks adult American Indians to report on and rate their experiences with tribal health care facilities. It was originally developed for the Choctaw Nation Health Service but has been adapted for use by other tribal nations. The survey's purpose is to assess patients' experiences with tribal outpatient clinics or other clinics with similar settings and to support the clinics in their efforts to evaluate the need for internal quality improvements.

Improve Patients' Experiences with Hospitals

Nationwide implementation of these Surveys has spurred many efforts to improve patients' experiences with care.

Improving Patient Experience

CAHPS® surveys play an important role as a quality improvement (QI) tool for health care organizations that use the standardized data to:

Identify relative strengths and weaknesses in their performance,

Determine where they need to improve, and

Track their progress over time.

In Korea

Treatment effectiveness holds considerable importance in the association between service quality and satisfaction in medical service studies. While complementary and alternative medicine (CAM) use grows more prominent, comprehensive evaluations of the quality of medical service at CAM-oriented hospitals are scarce. For example, the quality of medical services at a CAM-oriented hospital of Korean medicine is provided using the service encounter system approach and analyzes the influence of treatment effectiveness on patient loyalty. [6]

In Russia

According to the opinion of colleagues from the Siberian Federal University and KrasSMU them. prof. V.F. Voyno-Yasenetsky [1] analysis of official sources

regulating the quality control of medical organizations and scientific research in this area showed that in the field of medical services two methodological approaches to assess the quality of medical services were formed:

The industry one, based on the approach of the manufacturer. The methodical recommendations for assessing the quality of medical services are based on internal or external expert assessment. This approach is more focused on assessing the quality of the basic services of medical institutions, which refers to medical care [2].

The consumer-oriented approach. Guidelines for assessing the quality of medical services are based on the evaluation of consumers [3, 4, 5].

We should note that the authors support the methodical recommendations approved by the Ministry of Health of the Russian Federation for independent assessment of the quality of services rendered by medical organizations, based on a change in the paradigm of medical services from industry to consumer orientation, including as a general criterion for assessing the quality of service delivery relevant to the consumer approach:

- openness and availability of information about the medical organization;

- comfortable conditions for the provision of medical services and the availability of their receipt;

- waiting time for the provision of medical services;

- goodwill, politeness, competence of employees of the medical organization;

- satisfaction with the services provided [5].

At the moment, for the implementation of the consumer methodological approach to assessing the quality of the provision of services, a questionnaire method in the form of filling in questionnaires is used. The form of the questionnaire was approved by the Orders of the Mandatory Medical Insurance Fund No. 118 dated May 29, 2009 and No. 88 dated June 11, 2015.

These questionnaires can be completed on the Portal of an independent assessment of the quality of the conditions for the provision of services by medical organizations (https://www.rosminzdrav.ru/open/supervision/format/nezavisimaya-

sistema-otsenki-kachestva-okazaniya-uslug-meditsinskimi-organizatsiyami/anketa-dlya-otsenki-kachestva-okazaniya-uslug-meditsinskimi-organizatsiyami-nahodyaschimisya-na-territorii-sub-ektov-rossiyskoy-federatsii-gosudarstvennoy-munitsipalnoy-i-chastnoy-form-sobstvennosti). However, it is worth noting that not every patient wishes to search this form on the Internet independently.

Therefore, the representatives of the Mandatory Medical Insurance conduct a survey using paper questionnaires and their subsequent manual processing and analysis of the data using Excel tables.

As part of writing this scientific work, we took part in the survey and reported on the results in an article that was published in the Siberian medical journal No. 33 (4) 2018.

The survey was conducted in two medical institutions in Tomsk: OGAUZ "Children's City Hospital No. 2" and OGAUZ "City Clinical Hospital № 3 B.I. Alperovicha, who were the first in Tomsk to join the "Lean Polyclinic" project in May 2017.

The Ministry of Health of the Russian Federation, in collaboration with the Federal Medical-Biological Agency, the State Corporation Rosatom and other departments, has launched the Lean Clinic (LP) project to improve the quality of the organization of medical services.

LP is a federal project whose task is to increase the efficiency of work of medical institutions and the availability of medical care. It is called "Lean Polyclinic" because its goal is to introduce the principles of lean manufacturing in the outpatient clinic of medical institutions.

The word "lean" is borrowed from the Western concept of "lean production", aimed at eliminating all types of losses. For the first time its principles were formulated by Taichi Ono [2].

The objective of the LP project is optimization of the medical organization. Implementation of project activities is aimed at reducing queues, simplifying the appointment to a doctor, which, in turn, makes it possible to serve a much larger number of patients with the same resources.

In the survey were involved the patients who came to the medical organization for an appointment. These were men and women aged 18 to 86 years. In the children's clinic, the legal representatives of the children answered the questions of the questionnaire. Self-completion technology was used, but for older patients the questions were read out with response options. The form of the questionnaire was approved by the order No. 118 dated May 29, 2009 and No. 88 dated June 11, 2015. Each questionnaire had 12 closed-type questions with standard answers:

• satisfied (a);

• rather satisfied (a) than dissatisfied (a);

• rather not satisfied (a) than satisfied (a);

• not satisfied);

• difficult to answer.

The filling out of each form took from 3 up to 6 minutes. Questioners were chosen at random. A total of 600 people participated in the survey (during the period of six months from May, 2017 up to December, 2017).

It was necessary to answer several questions about the degree of satisfaction with the following characteristics of the work of the clinic, day hospital and hospital: technical condition and repair of premises, provision with modern medical equipment, organization of appointments to the doctor, waiting time for a doctor's appointment, waiting times for medical services after recording, availability of necessary laboratory tests, etc.

The results of the study were subjected to statistical processing and analysis in the program Statistica 6. Qualitative indicators are presented in the form of absolute and relative frequencies - n (%). To test the statistical hypotheses, the Pearson $\chi2$ test was used. Values of $p \leq 0.05$ were considered statistically significant.

The results of the survey indicate a change in public satisfaction with the quality of medical services provided and they are presented in Figure 1. If at the initial stage of the project only 55% of respondents were satisfied with the quality of medical services, by the 8th month of project implementation this number increased up to 76%. The use of "Lean Technologies" in organizing the work of a medical

institution had a positive effect in the opinions of patients. The number of those who found it difficult to answer dropped by half (from 32 to 16%); the number of dissatisfied with the quality of medical services decreased from 13 to 8%. It can be assumed that an increase up to 76% in the proportion of patients satisfied with the quality of medical services is associated with a decrease in the number of those who found it difficult to answer (Fig. 1, $p < 0.05$).
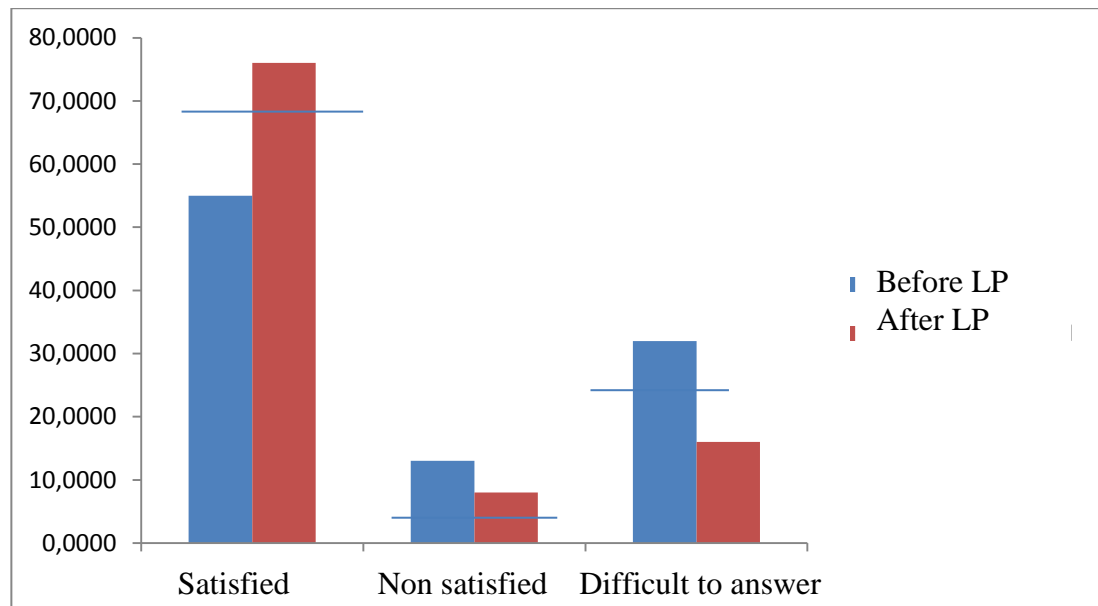

Fig.1 Patient satisfaction with the quality of medical services (%)

2 Experimental algorithm

2. 1 Necessity of a new method to gather information.

Due to the difficult and time-consuming work of collecting information when using paper questionnaires, we would like to offer a new research method using data from the Internet, namely social networks containing patient testimonials.

To detect evaluation posts, we compiled a dictionary of linguistic markers related to hospitals and medics. This list of them you can find in the Appendix.

The work of finding posts with evaluative information is divided into 2 ways:

• uploading information from the Internet to Excel tables with subsequent processing and analysis using the tool API VKontakte;

• "sifting" information from the Internet using the "Kribrum" program.

In the first case, we can unload the page from social networks (as it was done with VKontakte "White and Black list of Tomsk") and subject it to processing and analysis. Processing is done manually, i.e. a person views posts and selects positive and negative feedback. This way allows to get the information from anytime in past from the beginning of the existence of any site.

In the second case, we launch the program from a certain moment and it scans the entire Internet from this moment and finds information related to the desired subject and automatically analyzes the material found. The program needs to be configured, because at first it finds a lot of garbage information that does not contain patient reviews, but only mentions of the specialists themselves. To customize the program, it was necessary to develop a special algorithm.

2.2 Pilot launching

To begin with, a pilot project was launched in order to draw the first conclusions on the work of Kribrum and begin to customize the program.

2690 messages were collected using Kribrum from March 7 to March 20, 2019.

After the collection, a key sorting was performed in order to process the uploaded data and then use it to train the algorithm, which will automate this process in the future.

The sorting was carried out manually in the Excel table. Four girls read the message and attributed it to the garbage or determined the tonality.

The following characteristics were formulated:

• Positive is the presence of such evaluative words as: positive, good specialist, intelligent, saved, thank you, best and others that describe the described as something positive, it can also be an improvement, i.e. mention of change from good to best.

• The negative is the presence of such evaluative words as: horrible, bad, disgusting, and others that describe the described as something negative, it can also be a description of the deterioration of the situation ...

• Neutral is the absence of evaluative words, a dry statement of facts.

• Advertising and information about vacancies attributed to garbage.

1914 out of 2690 messages were classified as garbage. These included advertising posts, announcements for medical staff, information about vacancies.

As a result of the distribution of the remaining 776 messages by tone, we see the following picture:

Neutral - 0, (252)

Negative - 1, (201)

Positive - 2 (323)

On closer examination, it turned out that the subjective approach did its job and four people did not always evaluate the same information equally, despite prior agreement. It was concluded that we need to revise the results of the markup again

As a result, we have got the following information:

Neutral - 0, (214)

Negative - 1, (152)

Positive - 2 (252)

It also turned out that some were incorrectly classified as positive, such counted: 4 negative, 7 neutral, 4 contradictory, 2 relate to veterinary medicine.

We also consider necessary to note that 194 out of 252 positive are news reports, and only 44 are positive patient reviews.

From the 152 negative messages were incorrectly assigned to this category: 16 positive, 21 neutral, 0 controversial, 12 relate to veterinary medicine.

From the remaining 103 negative - 76 are news reports highlighting health problems, and only 27 are patient testimonials.

The final situation is like that: from 2690 messages were left 44 positive, 27 negative and 4 controversial. The percentage of garbage information is very high.

When analyzing the data, we noticed that not all messages fall into the filter. For example, on the forum they discussed the topic of doctors, and only one of many comments was found by the program. However, colleagues from TSU working with the program positively evaluate the work of Kribrum on data collection. Therefore, we note this fact as a small drawback of the program, which does not reduce its useful potential for collecting data on the global Internet.

Starting work on the research topic "Evaluation of medical services through the analysis of data from the Internet", such thoughts came up as: not everyone will write about positive aspects when receiving medical care and when receiving negative, the patient will not always decide to share his emotions with others . The case must be outstanding out of the ordinary: either very positive, or very sad. It is worth taking into account when analyzing the data obtained.

Following the analysis, we came to the following conclusions:

Automatic data collection and analysis can be used to monitor the situation in real time, provided that the tonality analysis process is automated;

A small amount of useful information (75 messages) collected during a short period (13 days) of time leaves hope for subsequent more productive data collection.

The most important task is to adjust the program Kribrum, i.e. to teach it to divide the useful information containing the patients review from the garbage

information containing a simple mentioning of the medical organizations and doctors themselves.

In order to fulfill it we used such a method of vectorization.

2. 3 The algorithm

The main task of the constructed algorithm is the automatic classification of reviews about medical institutions and doctors. All references to medical institutions and specialized specialists are collected using the Kribrum monitoring system (https://www.kribrum.ru/). The Kribrum system collects references to the object from Russian-speaking Internet resources: social networks, online media, blogs, thematic and regional forums and other resources.

For the period from April 1 to May 22, 35,935 references were made to objects in the Tomsk Region.

The sources of data are such social nets as Vkontakte, Facebook,

The list of references was cleared of repetitions and short messages less than 220 characters long.

To compile the training sample, 3396 mentions were manually selected and mapped into two classes, the following classes were used:

"Garbage" - references that do not contain information about the quality of the provision of medical care or services, mainly informational messages, advertisements, erroneously collected messages not related to the topic of medicine;

"Review" - references that will be used to describe the quality of the provision of medical care and services.

As part of manual processing of 3816 references, 420 reviews and 3396 messages belonging to the class "Garbage" were allocated.

To create an automatic text classification algorithm, the following standard machine learning libraries are used - Scikit Learn (https://scikit-learn.org/stable/), Pandas (https://pandas.pydata.org/), Numpy (https: // www.numpy.org/) and the NLTK Natural Language Analysis Toolkit (Natural Language Toolkit,

https://www.nltk.org/). The algorithm is implemented in the programming language Python 3.

At first, all references from the training sample were loaded, the texts were cleared of references, hash tags, numbers, special characters and punctuation marks, and repeated spaces were removed. Further, the texts were divided into separate words and cleared of "stop" words (words that do not carry a semantic load - pronouns, prepositions, numerals, etc.).

To use a variety of classification methods, it is necessary to provide texts of references in a vector form. The work uses the TF-IDF (TF - term frequency, IDF - inverse document frequency) approach, which uses word weights proportional to the frequency of these words in the document and inversely proportional to the frequency of words in all documents in the collection. The TF-IDF measure is often used to represent a collection of documents in the form of numerical vectors that reflect the importance of using each word from a certain set of words (the number of words in the set determines the dimension of the vector) in each document.

After all mentions were converted into vectors, the training sample of mentions was mixed randomly and divided into two parts: the train one for learning the algorithm, and the test one for validating the algorithm on unknown texts, but having a manually-marked class. The test sample included 20 percent of the entire training sample, i.e. 764 messages, which included 667 messages from the class "Garbage" and 97 reviews.

Two algorithms were used to classify the vectors obtained: the logistic regression and the support vector classifier. The logistic regression showed poor results, 83.2% grade accuracy was achieved, but at the same time, the completeness (the specific proportion of all feedback found) did not exceed 51%. The support vectors classifier showed acceptable results, the accuracy reached 89.1%, and the completeness of identification of all feedback from the training sample was 67%. This algorithm was chosen to automatically classify the remaining messages.

The automatic classification with the chosen algorithm gave us 442 messages marked as containing references. Then we continued to classify manually and as the

result we found 11 references with information about patient satisfaction. 6 of them were positive and 4 were negatives. The one contained both negative and positive assessment of the received medical service.

TASK FOR THE CHAPTER
"FINANCIAL MANAGEMENT, RESOURCE EFFICIENCY AND RESOURCE SAVING"

Student

Group	Name
1ДМ7И	Natalia V. Kopysova

School	Research School of Chemistry & Applied Biomedical Sciences		
Education level	Postgraduate	Specialization	Biomedical Sciences and Engineering

Background of the "Financial management, resource efficiency and resource saving":	
1. The cost of resources research : logistics, energy, financial, information and human	*The salary of the head - 47104 rubles per month.* *Engineer's salary - 21760 rubles per month.*
2. Regulations and standards for resource consumption	*According to the standard taxation system.* *Federal Law No. 212-FZ of 24.07.2009* *Regional coefficient 30%.* *Amortization 33%.*
3. Tax system, rates of taxes, deductions, discounting and lending	*Labor tax 30%*
The list of subjects of the study, design and development:	
1. Evaluation of commercial and innovative potential of R&D	*Analysis of potential consumers; QuaD-analysis; SWOT analysis*
2. Development of the charter of the scientific and technical project	*Project initiation: identifying project stakeholders, project goals and results*
3. Planning R&D management process: structure and schedule, budget, risks and organization of procurement	*Definition of work stages; determination of labor intensity of work; development of Gantt schedule; Risk analysis.*
4. Resource, financial and economic efficiency assessment	*Determination of operating costs*

List of graphic material
1.   Chart of the market segmentation for medical service improvement *2.   Evaluation matrix for QuaD analysis* *3.   SWOT matrix* *4.   Objectives and results of the project* *5.   Project working group* *6.   Estimated project cost* *7.   Key risk reduction measures*

Date of the task for the chapter	11.04.19

The task was issued by:

Positon	Name	Degree	Signature	Date
Senior Lecturer	Nina V. Potekhina			

3 Financial management, resource efficiency and resource saving

Introduction

Within the framework of this final qualifying work, research is being carried out to study patient satisfaction with the quality of medical services, the result of which is the development of requirements for creating a data processing algorithm.

The viability of any scientific research is determined by the commercial value of this development. Commercial attractiveness is an important criterion when looking for sources of funding for research.

The commercial attractiveness of a scientific study is determined not only by the excess of technical parameters over previous developments, but also by how quickly the developer is able to determine the price of development, market demand, what is the budget of a scientific project, how long it will take to enter the market, etc.

In this section one must determine the duration of the work, the calculation of labor costs for the project. The efficient production should be organized to reduce costs. What is impossible without the economic justification of all engineering solutions. Other task of this chapter to analyze potential consumers of research results and to evaluate the prospects of developing a market and the feasibility of investing in a research project.

3.1 Pre-project analysis

3.1.1 Potential consumers of research results

To analyze consumer research results, it is necessary to consider the target market and conduct its segmentation.

We define that the target market of our final product is the market of medical institutions and administrative institutions. In turn, the market is divided into separate segments - groups of consumers of the final product. Thus, we need to segment the

market of medical institutions and administrative institutions. In our case, the market segments are medical institutions, as well as state administrative institutions.

We define segmentation criteria as the size of the medical facility.

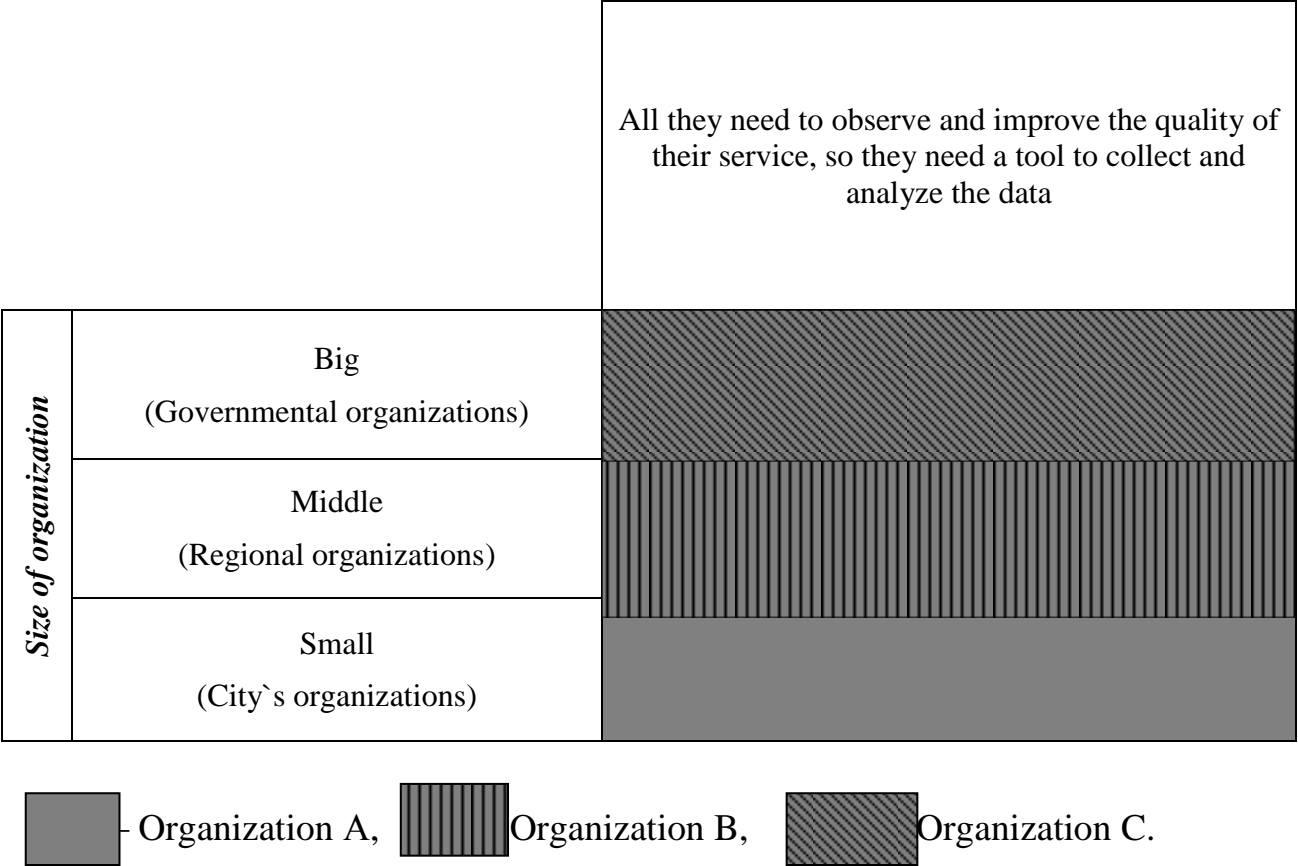- Organization A, Organization B, Organization C.

Figure 3.1 – Chart of the market segmentation for medical service improvement

Hence, the potential consumers of this project can be different type organizations as huge governmental ones, medium regional organizations and small ones of a city.

3.1.2 QuaD analysis

The QuaD technology makes possible to evaluate the prospects of developing a market and the feasibility of investing in a research project. The results of the evaluation are presented in Table 3.1.

Table 3.1 – Evaluation matrix for QuaD analysis

Criteria for evaluation	Weight criterion	Average score	Maximum score	Relative value (3/4)	Weighted average (5x2)
1	2	3	4	5	6
Productivity	0,07	80	100	0,8	0,04
Fault tolerance	0,17	90	100	0,9	0,153
Unification	0,1	50	100	0,5	0,05
Security	0,05	80	100	0,8	0,04
The need for memory resources	0,13	95	100	0,95	0,1235
Functional power	0,1	75	100	0,75	0,075
Ease of use	0,1	40	100	0,4	0,012
Scalability	0,06	75	100	0,75	0,045
Product competitiveness	0,07	50	100	0,5	0,035
Market prospects	0,07	85	100	0,85	0,0595
Price	0,1	40	100	0,4	0,04
Total	1				**0,673**

According to the results of assessing the quality and prospects, it can be concluded that the prospects of the current development are above average. By reducing the complexity of operation it is possible to improve this development. Despite the high cost, at this stage to reduce this figure is not possible.

3.1.3 SWOT analysis

SWOT analysis of the enterprise is done in order to analyze the strengths and weaknesses of the enterprise, opportunities and threats. SWOT analysis is presented in the Table 3.2.

Table 3.2 – SWOT matrix

Strengths	Weaknesses
1) A new algorithm to process data about patient satisfaction with medical service that was announced in the internet. 2) This project can be applied to numerous fields where analyzing algorithm is required.	1) Currently our project is not complete. 2) Small quantity of references to patient satisfaction in the internet.
Opportunities:	Threats
1) This is an entirely new field in medical services evaluation. 2) The project can provoke the interest of commercial organizations.	1) There are a lot of fast growing enterprises in the digital sphere that are developing algorithms to process data and they can develop a new method that will be better than ours.

When considering weaknesses, we can conclude that the problem is also in the issue of funding, which will help to increase the number of trained employees, and, consequently, the time spent for development will be reduced.

Strengths, such as the relevance of the study, its novelty and relevance can ensure that the research will be in demand, which will also lead to an influx of funding. These factors will help to develop opportunities for promoting research in a dedicated market segment, as well as reduce the number of weaknesses and threats that affect the ability of this work to compete.

When considering opportunities, this is an entirely new field in medical services evaluation, hence there are lots of emerging customers. The project can provoke the interest of commercial organizations to use big data in analyses of actual situation in service and to improve the quality.

In order to eliminate this threat we need to improve our development, i.e. to make it more accurate and faster.

3.2 Project Initiation

In the framework of the initiation the objectives and expected results are formulated. It also identifies development stakeholders and possible limitations.

3.2.1 Objectives and results of the project.

The stakeholders of the project are presented in the table 3.3 and the objectives and results are presented in the table 3.4.

Table 3.3 – Stakeholders of the project

Project stakeholders	Stakeholder expectations
Project Manager	To use the project results in further research
Project Contractor	To increase qualifications by working for science
Customer Organization	To use the results of intellectual activity to improve the competitiveness of the organization
Project sponsor	To improve the quality of medical services in the country.

Table 3.4 – Objectives and results of the project

Objectives of the project	Research the factors affecting patient satisfaction with medical services to develop an algorithm for automatic searching and sorting evaluation messages
Expected results of the project:	An algorithm developed for automatic searching and sorting evaluation messages
Criteria for acceptance of the project result:	1. All planned works have been completed; 2. The search for the necessary information have been done; 3. The results of research have been obtained.
Requirements for the result of the project:	**Requirement:**
	1. The algorithm must be accurate
	2. The design of the algorithm must be clear
	3. The search results must reflect the patient`s opinion
	4. The algorithm must be self-sufficient
	5. The conclusions must be done

3.2.2 Project organizational structure.

Table 3.5 – Project working group

№	Full name, main place of work position	Role in the project	Functions	Labor costs hour.
1	Brazovsky K.S., professor at TPU	Project Manager	Coordination of the research project	9
2	Kopysova N.V.	Project Contractor	Implementation of research work on the project.	80
			Total	89

3.2.3 Limitations and assumptions of the project

Table 3.6 – Project limitations

Factor	Limitations / Assumptions
3.1. Project Dates:	30.01.2017-10.06.2019
3.1.1. Date of approval of the project management plan	30.01.2019
3.1.2. Project completion date	10.06.2019
3.2. Other limitations and assumptions	Limited time for the PC, due to the harmful effects of EM radiation.

The undertaken analysis have shown that the project has got a huge volume of work to do and the stakeholder expect rather high quality results from the project contractor.

3.3 Planning the management of scientific and technical project

Planning the management of a scientific and technical project consists in drawing up a list of works necessary to achieve the set goal, determining the timing of their implementation.

Planning the stages of work on the implementation of R & D includes the compilation of a list of stages and work, as well as the distribution of executors for all

types of work. Table 3.7 shows the main stages and content of work with the distribution of responsible performers.

It is advisable to apply linear planning with the construction of the Gantt chart presented in the table. The schedule is constructed by month and decade (10 days) for the time period of the scientific project.

Table 3.7 – Calendar plan project

Codes of work	Name	Duration, days	Date of beginning	Deadline	List of executors
1	Formulation of the problem	5	30.01.19	03.02.19	Sientific Adviser (SA), Master student (MS)
2	Drafting and approval of Task	4	06.02.19	09.02.19	SA
3	Literature review	18	10.02.19	27.02.19	MS
4	Literature discussion	6	28.02.19	06.03.19	SA, MS
5	Forming the plan project	2	07.03.19	09.03.19	SA, MS
6	Choosing a study design	14	11.03.19	25.03.19	SA, MS
7	Conducting experiments	28	26.03.19	22.04.19	MS
8	Editing the explanatory note	14	23.04.19	11.05.19	MS
9	Editing the graphic material	7	13.05.19	20.05.19	MS
10	Summing up	10	21.05.19	30.05.19	SA, MS
	Total	108			

We will construct a linear schedule of R & D (Table 3.8), on which we will show the sequence of work and the timing of the steps. The calendar schedule is made on the first execution, since it takes less time and is optimal for the implementation of the master's thesis.

Table 3.8 – Plan of the project

Codes of work	Type of work	Executors	$T_к$, days.	Duration of work													
				February			March			April			May			June	
				1	2	3	1	2	3	1	2	3	1	2	3	1	2
1	Formulation of the problem	SA	5	▒													
		MS		█													
2	Drafting and approval of Task	MS	4	█													
3	Literature review	MS	18		█	█											
4	Literature discussion	SA	6				▒										
		MS					█										
5	Forming the plan project	SA	2					▒									
		MS						█									
6	Choosing a study design	MS	14					█	█								
7	Conducting experiments	MS	28							█	█						
8	Editing the explanatory note	MS	14									█					
9	Editing the graphic material	MS	7										█				
10	Summing up	SA	4											▒			
		MS	6											█			

▒ – Scientific adviser,   █ – Master Student

The formed calendar plan is an R & D schedule that is optimal for the master's thesis.

3.4 Determination of the complexity of work

Labor costs in the majority of cases, constitute the bulk of the development costs, therefore an important point is to determine the capacity of work of each of the participants in research.

The complexity of the implementation of scientific research is evaluated by experts in man-days and is probabilistic in nature, as it depends on many factors taken into account it is difficult to determine the expected (mean) value of the complexity of the following formula:

$$t_{\text{ож}i} = \frac{3t_{\min i} + 2t_{\max i}}{5}, \text{ where} \tag{1}$$

1) $t_{\text{ож}i}$ – the expected performance of the complexity of the No. i person-days of work;.;

2) $t_{\min i}$ – the minimum possible the complexity of implementation of a given No. i operation (an optimistic estimate: assuming the most favorable circumstances), man-days; t;

3) $t_{\max i}$ – maximum possible the complexity of performing a given No. i operation (pessimistic estimate: assuming the most unfavorable combination of circumstances).

After the calculation of $t_{\text{ож}i}$, we calculate the duration of each type of work in work-days:

$$T_{\text{p}i} = \frac{t_{\text{ож}i}}{\text{ч}_i}, \text{ where} \tag{2}$$

1) $T_{\text{p}i}$ – the duration of a single work, work-days;

2) $t_{\text{ож}i}$ – the complexity of the expected performance of a work, man;.

3) ч_i – the number of executors performing at the same time the same job on the same stage, man.

$$T_{\text{к}i} = T_{pi} * k_{\text{кал}} \qquad (3)$$

where $t_{\text{к}i}$ – the duration of the i-th work in calendar days;

t_{pi} – the duration of the i-th work in work days;

$k_{\text{кал}}$ – calendar factor.

The calendar factor is determined by the following formula:

$$T\text{кал} = \frac{T_{\text{кал}}}{T_{\text{кал}} - T_{\text{вых}} - T_{\text{пр}}} = \frac{365}{365 - 66} = 1{,}22 \qquad (4)$$

where $t_{\text{кал}}$ – quantity of calendar days per year;

$t_{\text{вых}}$ – quantity of days off per year;

$t_{\text{пр}}$ – quantity of holidays per year.

In accordance with the production calendar (for a 6-day working week) in 2019, 365 calendar days, 299 working days, 66 days off / holidays.

3.5 Research budget

Budget planning research is done by budgeting for individual items of expenditure of all types of necessary resources. When forming the research budget, the cost grouping is used according to the following items:

1) the basic salary of the executors of the project,

2) additional salary of the executors of the project,

3) amortization deductions,

4) contributions to extra-budgetary funds (insurance contributions),

5) overhead costs.

3.5.1 Basic salary

The initial regulations wages of these categories of workers is salary, which determines the level of monthly salary, depending on the volume of work and responsibility.

The structure of the basic salary includes premiums paid monthly from the salary fund in the amount of 20 to 30% of the rate or salary. The salary is calculated according to the following formula:

$$З_{зп} = З_{осн} + З_{доп}, \text{ where} \tag{3}$$

1) $З_{осн}$ – basic salary;
2) $З_{доп}$ – additional salary.

$$Зосн = Здн \times Тр, \text{ where} \tag{4}$$

1) $З_{дн}$ – average daily wage of an employee, rubles;
2) $Т_р$ – the duration of the work performed by the employee, work days

The average daily wage is calculated by the formula:

$$З_{дн} = \frac{З_м \cdot М}{F_д}, \text{ where} \tag{5}$$

1) $З_м$ – monthly salary of an employee, rubles;
2) М – the number of months of work without vacations during the year (with a vacation of 48 work days M = 10,4 months, 6-workday per week);
3) $F_д$ – valid annual fund of working time of scientific and technical personnel, work day.

Table 3.9 – Working day balance

Working time	Scientific adviser	Master student
Calendar number of days	365	365
Quantity of non-working days - weekend - holidays	66	66
Loss of working time - vacation - absences due to illness	56	56
Valid annual working time fund	243	243

Monthly salary of an employee:

$$З_м = З_{тс} \cdot (1 + k_{пр} + k_д) \cdot k_р, \text{ where} \tag{6}$$

1) $З_{тс}$ – salary at the tariff rate, rub.;

2) $k_{пр}$ – premium coefficient equal to 0,3 (i.e. 30% from $З_{тс}$);

3) $k_{д}$ – coefficient of surcharges and allowances is approximately 0,2 – 0,5;

4) $k_{р}$ – regional coefficient equal to 1,3 (for the Tomsk region).

Table 3.10 – Calculation of basic salary

Executors	Здн, rub.	Кпр	Кд	Кр	Тр	Зосн
Engineer	2058	0.3	0.4	1.3	80	164640
Scientific adviser	4455,3	0.3	0.4	1.3	9	35642.4
Total	200282.4					

3.5.2 Additional salary

It presents 12-15% of the basic salary, so the additional salary of the executors of the project will be 24033.89 rubles.

3.5.3 Amortization

Taking into account the fact that the PC that was used to edit the work, has an initial cost of 45,000 with a useful life of 3 years and the editing of the work took place within 3 months. Then:

- amortization rate:

$$Ан = \frac{1}{n} * 100\% = \frac{1}{4} \times 100\% = 25\,\%$$

- annual amortization:

$$Аг = 45000 \times 0,25 = 11250 \text{ roubles}$$

- monthly amortization:

$$Ам = \frac{11250}{12} = 937.5 \text{ roubles}$$

- total amortization:

$A = 937.5 \times 4 = 3750$ roubles

      Total amortization is 3750 roubles.

3.5.4 Contributions to extra-budgetary funds (insurance contributions)

The value of contributions to extra-budgetary funds is determined on the basis of the following formula:

$$З_{внеб} = k_{внеб} \cdot (З_{осн} + З_{доп}), \text{ where} \qquad (7)$$

  $k_{внеб}$ – Labor tax is equal to 30% (0,3).

      Total contributions to extra-budgetary funds are 67294.89 roubles.

3.5.5 Cost of the soft programs

-     Access to Kribrum- from 75000rub
-     Microsoft Windows 10 Professional RU x32/x64 - 4000rub

     Total cost is 79 000 rub.

3.5.6 Overheads

      Overhead costs take into account other expenses of the organization that are not included in the previous cost items: printing and photocopying of research materials, payment for communication services, electricity, postal and telegraph expenses, reproduction of materials, etc. Their value is calculated by the following formula:

$$З_{накл} = (суммастатей1 \div 5) \cdot k_{нр}, \text{ where} \qquad (8)$$

$k_{нр}$ – coefficient, taking into account overheads, equal to 0,16.

      Total overheads are 59897.79 rub.

3.5.7 Forming the research budget

After calculation of the previous expense items we can form the estimated project cost of research work, presented in the table 3.11.

Table 3.11 – Estimated project cost

Name	Summ, rub.	Specific gravity, %
Basic salary	200282,4	46,1
Additional salary	24033,89	5,5
Amortization	3750	0,9
Contributions to extra-budgetary funds	67294,89	15,5
Cost of the soft programs	79000	18,2
Overheads	59897,79	13,8
Total	434258,96	100

3.6 Risks of research project

Risk is the possibility of the occurrence of some adverse event that entails the occurrence of various kinds of losses. A unified risk classification project does not exist. We can single out the following main groups of risks inherent in almost all projects: political, economic, social, technological, environmental, financial, organizational, marketing, personnel, technical.

To begin with, the main risk groups of the project are determined, it is explained what each risk group is.

Table 3.12 – Definition of risk

№	Name of the risk	Description
1	Technological	Soft programs failure
2	Financial	Lack of financing
3	Staff	Lack of trained staff
4	Technic	Equipment failure

Then, the risk probability is estimated using the risk probability scale and the loss level assessment scale. The result of this stage is presented in the form of tables 3.13 and 3.14.

Table 3.13 – Risk probability scale

№ п/п	Name of the risk	Risk probability assessment (low, medium, high)
1	Technological	Medium
2	Financial	Medium
3	Staff	Medium
4	Technic	Medium

Table 3.14 – Loss level assessment scale

№ п/п	Name of the risk	Loss level assessment (low, medium, high)
1	Technological	High
2	Financial	Medium
3	Staff	Medium
4	Technic	High

According to the previous analysis data we develop basic risk reduction measures.

Table 3.15 – Key risk reduction measures

№ п/п	Name of the risk	risk reduction measures
5	Technological	It is necessary to train staff before using the soft programs
6	Financial	Participate in competitions with funding
9	Staff	Additional training of the staff
10	Technic	Timely maintenance, careful handling and repair of equipment as needed

Thus, the risks associated with conducting this scientific and technical research as well as measures to reduce them were considered in this section.

According to the previous analysis the potential consumes of the scientific project can be an medical organization interested in their medical service improvement and the governmental organizations responsible for the medical service in the organizations of their region.

The results of this research project application will be useful for medical organizations in improving their service by marking the directions that need to be improved.

List of student`s publications

Соловьев А. А. , Копысова Н. В. Удовлетворенность пациентов качеством медицинских услуг на разных этапах реализации проекта «Бережливая поликлиника» в Томской области // Сибирский медицинский журнал. - 2018 - Т. 33 - №. 4. - С. 154-157