Saint Petersburg University

Graduate School of Management

Master in Public Management

APPLICATION OF “SMART CITY” PROJECTS FOR SUSTAINABLE DEVELOPMENT OF SAINT PETERSBURG: A CASE OF HEALTHCARE

Master’s Thesis by the 2nd year student

Concentration — Master in Public Management

Ivan Sergeevich Lapov

Research advisor:

Associate Professor, Tatiana Moiseevna Sklyar

Saint Petersburg

2018

**ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ**

**ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ**

 Я, Лапов Иван Сергеевич, студент 2 курса магистратуры направления направления «Государственное и муниципальное управление», заявляю, что в моей магистерской диссертации на тему «Применение проектов “умного города” для устойчивого развития Санкт-Петербурга (на примере здравоохранения)», представленной в ГАК для публичной защиты, не содержится элементов плагиата.

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Подпись студента) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_24.05.2018\_ (Дата)

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 **THE MASTER THESIS**

 I, Lapov Ivan, 2 year master student of the program «Public Management», state that my master thesis on the topic «Application Of “Smart City” Projects For Sustainable Development Of Saint Petersburg: A Case Of Healthcare» which is presented for the public defense for the Official Defense Committee, does not contain any elements of plagiarism.

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**АННОТАЦИЯ**

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| --- | --- |
| Автор | Лапов Иван Сергеевич |
| Название магистерской диссертации | Применение проектов “умного города” для устойчивого развития Санкт-Петербурга (на примере здравоохранения) |
| Факультет  | Высшая Школа Менеджмента |
| Направление подготовки | 38.04.04 «Государственное и муниципальное управление» |
| Год | 2018 |
| Научный руководитель | Скляр Татьяна МоисеевнаДоцент кафедры государственного и муниципального управления |
| Описание цели, задач и основныхрезультатов | Главной целью исследования является оценка применения инновационных проектов здравоохранения в Санкт-Петербурге, являющаяся основой для составления потенциально практически применимой модели для частных и государственных медицинских учреждений для оценки возможности внедрения определенной инновации с учетом факторов внешней и внутренней среды.Выделяются следующие задачи:* определить страновые особенности, которые отличают процесс применения концепции «умного города» от зарубежного опыта;
* изучить кейсы применения инновационных проектов сфере здравоохранения концепции «умного города»;
* выделить отличительные характеристики городской среды Санкт-Петербурга в рамках применения инновационных проектов в сфере здравоохранения;
* определить внешние и внутренние факторы среды медицинских организаций Санкт-Петербурга, влияющие на процесс применения медицинских инновации.

Главным результатом работы является составленная модель оценки внутренних и внешних факторов окружающей среды для медицинских организаций Санкт-Петербурга в рамках применения проектов инновационного здравоохранения, а также набор рекомендаций по состоянию благоприятной для развития инновационных проектов здравоохранения среды |
| Ключевые слова | Умные города, инновации в здравоохранении, частные и государственные медицинские учреждения, городское развитие |

**ABSTRACT**

|  |  |
| --- | --- |
| Master Student's Name | Lapov Ivan |
| Master Thesis Title | Application Of “Smart City” Projects For Sustainable Development Of Saint Petersburg: A Case Of Healthcare |
| Faculty | Graduate School of Management |
| Main field of study | 38.04.04 «Master in Public Management» |
| Year | 2018 |
| Academic Advisor’s Name | Tatyana M. SklyarAssociate Professor, Department of Public Administration |
| Description of the goal, tasks and main results | The goal of the research lies in assessing implementation of healthcare innovations projects in Saint Petersburg environment, preparing a model for probable further practical usage by public and private medical organizations while deciding to adopt an innovation. The tasks are as follows:* to define country-specific factors that distinct applicability of smart city concept from foreign experience;
* to study cases of smart city innovative projects in healthcare both in Russia and abroad;
* to verify aspects of healthcare sector in Saint Petersburg for further smart city project implementation;
* to define external and internal factors influencing innovative projects application in medical sector implementation model.

The main results contain finalization of model for assessing internal and external environmental factors for innovative healthcare project application and a set of recommendations to controlling institutions on how to prepare the environment for development of healthcare sector in Saint Petersburg  |
| Keywords | Smart cities, healthcare innovations, public and private medical organizations, Saint Petersburg urban development |

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# CHAPTER 1. DESCRIPTION OF SMART CITY PHENOMENON

## 1.1 Background: defining the smart city concept

The phenomenon of smart cities is becoming more and more popular with every day. Such approach to urban management is now familiar not only to people, who work in public management, but also to other people: the quantity of researches, studies and publications is rapidly increasing, which makes the topic a really “hot” one. Significant interest is formed by studying the concept in relation with specific case studies and possible ways of bringing this phenomenon to actually existing environment.

The topic of the master thesis can be classified as rather significant and unique, since now the list of publications of Russian authors on smart cities is quite limited, mentioning basic facts and description of the concept not deepening much into special points about its applicability in Russian environment, especially in the sphere of healthcare. The thesis is not concentrated only on basic characteristics of smart cities, but also on creation of the specific concept of smart city oriented project application, methodology of application and on the factors, influencing implementation of smart city in the sphere of healthcare, prepared especially for Saint Petersburg environment.

Nowadays cities of many countries are keep on gaining a special meaning, and it is implied by a significant role of cities in national, and even global development. Moreover, the number of urban inhabitants is steeply increasing (UN, 2014). The level of quality of life in a city is depending upon the local administration, that is why modern cities face serious requirements, such as presence of available traffic infrastructure, high safety of urban territories, ecology and developed city management. But as cities are facing increasing quantities of inhabitants, city governments tend to be, as well, required to fulfill emerging needs of people. This sets a number of tasks, which have to be related to urban transformation and further development.

The concept of smart city development, which is also called a “digital city”, is based on provision of modern conveniences for everyday life through implementation of innovative edge-cutting technologies. Such technologies are concentrated on effective and ecological usage of urban infrastructure and bringing use to city residents. A smart city is based on development, which is seriously related to informational technologies. The main stimulus for smart city creation is provision of improving infrastructure through special city management approach. The list of infrastructural objects, where the concept of smart cities can be applied, include the following:

* schools;
* green zones;
* traffic systems;
* electric grids;
* water supply systems;
* hospitals;
* etc.

As it has already been mentioned, modern cities have to adopt some transformations due to a number of emerging needs of city inhabitants and general environment aspects. One of the most important tasks facing cities today is the development of urban infrastructure forming "smart environment". Cities are the place of residence, work, and leisure for millions of people, and one of the most crucial problems is large amount of time by people on the road and in traffic jams. The solutions leading to building new roads or increasing the capacity of the old doesn’t give the expected effect, as it has been a spread practice for many cities in the world. Only the planning and application of new long-term methods can have a positive effect. That means, that to solve this problem in an up-to-date manner and fulfill people’s requirements it is needed to apply new principles of city planning in order to provide better availability of public service and to organize roads in the most efficient way (Zanella, Bui and Castellani, 2014).

The next task covers safety as a social factor, and it can be done via developing informational-communicational systems to provide better counteraction on crimes alongside with ecological safety.

Here we face ecological issues: it is clear, that with growing urban population ecological environment, most probably, will suffer. To solve this issue it is required to introduce intellectual systems to control the level of pollution and to toughen existing laws and norms on emissions (Abdoullaev, 2011).

Low mobility of the city inhabitants might also appear and become a serious problem: existance of uncomfortable accomodations (for instance, homes in remote city districts). Absence of careful planning and connection to traffic infrastructure while creating massive high-rise buildings doesn’t fully solve lack of “living space” for people, but this issue can be sorted out by development of building technologies, materials and standards, alongside with implementation of “smart home” systems – technologies being installed into homes to automate a number of processes (Benevolo, Dameri and D’Auria, 2016).

One more issue concerning social aspects is saving cultural heritage: here the new IT systems and security of all cultural and historical legacy objects are required to create city-wide community of people and develop their self-identification (Lombardi, Giordano, Farouh and Yousef, 2012).

Another factor to be noted when analyzing the current situation with the development of cities is public participation in solving problems of the city and its directions of development. In connection with the development of information technologies and means of communication today it is necessary to apply the mechanism of inclusion of city residents into the process of discussion and making important management decisions. Therefore, the following methods are based on the "smart" management of the city, which can be achieved via stimulating people to participate in the decisions, taking surveys and making various committies: and all of it with the usage of modern IT solutions (Mishra, 2013).

After reviewing these issues, which appear because of the increasing urbanization, it is clear, that these very issues become incentives for cities to “go smart”.

But what actually is a “smart city”? Smart cities are believed to work for the future economic, social and ecological environment, as it was sorted out earlier in this work. The main goal of smart city is to raise the efficiency of urban infrastructure and services. Nowadays this concept is spreading indeed very fast, separate smart city projects were implemented in more than 2500 cities worldwide so far. Though many people understand the concept as an innovative approach to city management there is still no unified definition of what actually a smart city is. The problem here arises, that still there is a variety of definitions of the concept, but due to the fact, that it covers different infrastructural spheres, a lot of existing definitions cover only specific aspects, which refer to a specific sphere, and do not mention other spheres. What is meant here: for instance, as it has been mentioned above, some definitions contain only ecological aspects, not introducing infrastructure or social aspects of smart city approach. The reality is that the final idea of a smart city is to give city inhabitants a special environment, which can be done by the new ways of urban management. Such new urban management approaches shall count all aspects of urban life, relate one with another and give a complex approach finally. This means, that working on the development of a specific sphere of urban infrastructure alone will not solve other infrastructure issues (Monzón, 2015).

While analyzing existing definitions for the concept of smart cities it is possible to make a conclusion, that the main focus is being set on infrastructure as the main and, basically, central idea of the concept, and this infrastructure aims to be uniting all city systems (Nam and Pardo, 2011). Once again, it is vital to highlight the following: smart city concept is based on an integrated approach to city management and development in a balance with institutional, social, ecological and technological systems.

It is not a secret, that there is some critical attitude towards the concept: this is mainly affected by its uncertainty, as well as some ways of its application and its extensive use, which is not aimed at solving problems, but distraction from them. Some critics believe that the whole idea remains poor in terms of specifics. There is an opinion that studying the concept is confronted with the fact that there is not much information on the topic (Calzada and Cobo, 2015).

It is also not a secret that creating reasonable living conditions in a fast-changing urban environment and increase of urban inhabitants needs correlation with a clear picture of what is actually a phenomenon of a “smarter” city. Still, as it has been mentioned before, the approach itself is still in the stage of forming. But despite this fact this term is used all over the world in a variety of contexts. Sometimes the term “smart city” is supposed to have extremely close connection with “digital city” or “intelligent city”. Here it is reasonable to give a brief list of various explanations of the definition for the term itself to describe it from divergent angles. In regard with the scientific point of view a smart city is a safe, eco-friendly and efficient urban center of the future with cutting-edge infrastructure of technologies (electronics, networks, etc.) that stimulates sustainable development in terms of economy and better quality of life (Hall, 2000).

Another connotation of the concept suggests: a city becomes “smart” one when the investments into human capital and social infrastructure, as well as investments into both traditional, modern environment – here by traditional environmental infrastructure transport system is meant, and by modern infrastructure the modern technological solutions are meant – are the reason for growth of economy with sustainability and higher convenience of living environment: these investments are intended to be supported by reasonable natural resources management via urban city management, also formed with participation of urban inhabitants (Caragliu and Del Bo, 2009).

One more concept describes a smart city as the one, which has a clear-stated strategy of development in terms of economy as a starting point, but without lack of attention to human capital development, urban management development, natural environment protection and development of quality of life, supported by ongoing realization of such strategy. And such development is basically supported by city inhabitants’ activities, which act not only conscious, but are capable of taking solutions with no limitations (Giffinger and Gudrun, 2010).

From the urban perspective a smart city is a developed city with cutting-edge technological achievements, which unites people, informational flows, elements of urban infrastructure, alongside with simplified city management system and usage of new technologies for advancement of environmental protection, as well with creation with competitive and innovative trade and raise of life quality (C40 Cities Climate Leadership Group, 2014). Here an example of Amsterdam as a smart city is presented, which uses innovative technologies and special social policies, stimulating reasonable behavior of inhabitants on consumption of energy for resistance to climate change. Due to that the program of Amsterdam development is said to be implementing a unified approach towards forming a sustainable and economically developed city that is decreasing its carbon footprint (Amsterdam Smart City site, 2017).

 Another approach from technological perspective suggests that a smart city is the one using smart calculating technologies for making more intellectual, integrated and efficient crucial city infrastructures, such as healthcare, administration, real estate, transport, education, communal services and security.

One more approach suggests that the base for a smart city is intellectual exchange of information: the city itself analyzes and broadcasts this flow of information to city inhabitants and businesses, operating with it for making the whole ecosystem sustainable and cost-efficient. The information transition is based on the model of “smart” operational management, being developed especially for city “augmentation” in a sustainable format (Bartels, 2011).

Last but not least example here covers the following definition: a smart city is an administrative unit for its inhabitants (districts, cities or regions), which is operated under a unified approach for informational technologies usage, which are working for providing continual economic development of such administrative unit (Achaerandio, 2011).

All in all, smart-city approach is as well intended to make some valuable progress on cutting the costs and generating incomes, this feature is one of the basic ones for such type of infrastructural development methods. The graph below shows the forecast on annual revenue generation by smart-city projects worldwide (Graph 1 Forecasting annual revenue generation by smart-cities) (Woods, 2014):

Graph 1 Forecasting annual revenue generation by smart-cities

*Source: Woods (2014)*

## 1.2 Literature overview

 This part of the work contains literature review of the topic within the framework of differences in perception of the concept of smart cities between Russian and foreign authors. Since the thesis is concentrated on implementation the phenomenon in Russian environment, it is crucial to look at the concept from the perspective of Russian authors for further comparison with the foreign ones.

Some features of the concept were already defined in the background, such as different ways to give definition of the concept and various aspects of smart infrastructure, that is why the literature review starts with direct comparison of the studies with an intention to detect differences and relate them to country-specific factors or others. Here it is logical to admit, that the number of works, concentrating on the topic of smart cities has been gaining popularity and increasing since the topic became to be discussed.

While taking a general look at the available sources on the master thesis topic it was noticed, that the authors, revealing some data on the concept are widely (in terms of geography) spread worldwide, but the most significant papers are presented by authors from European countries, America and Canada. This is really reasonable indeed: smart city is an extremely popular approach nowadays everywhere, but European countries and America tend to have more examples of the concepts’ implementation. In the graph below the information about the quantity of issued papers on the topics of smart city or digital city is given (Graph 2 Number of papers about smart city and digital city) (Cocchia, 2014):

Graph 2 Number of papers about smart city and digital city concepts

*Source: Cocchia (2014)*

Many of the sources publically available, defining, describing or giving some insights on the topic of smart cities have general descriptive features of the concept, by that is meant, that if the comparison with other more developed scientific topic would have been made, the degree of diving into the topic of smart cities would be visible: it is clear, that the topic is new, and there are not as many clarifications, more detailed and deepened research rather than many other academic papers, describing older concepts, but this is obvious and is as well expected. That is a reason why critical opinion stating little quantity of available data on the topic (Hollands, 2008) is proved from a specific point of view.

Other point for further discussion covers search for the main factor or component intrinsic for a smart city. It is considered, that such significant factor is ICT (information and communication technologies) infrastructures. Despite that, a number of researches on the role of human capital, education, social capital, ecological interests, perceived as main growth drivers of smart cities exist as well. The European Union is constantly making valuable effort for the evolution of strategy to reach urban growth in a smart relation to its capital districts.

Not only the European Union, but also other international institutions support idea of interconnected ICT-based type of development. Intellectual forum of the community produces researches of local effects of ICT, which by now has spread worldwide. On the contrary, “OECD” and “EUROSTAT” admit a special role of innovations in ICT sectors alongside with providing coherent indicators (Oslo Manual, 2005). This forms a base for urban innovations researches. Another position exists for highlighting infrastructure of soft communication while choosing economic indicators (Del Bo and Florio, 2008).

As far as we can see, there are different positions. For now it it logical to come one more step closer to the master thesis topic discussion and compare the vision of Russian authors to the foreign ones. Sam Allwinkle and Peter Cruickshank (Allwinkle and Cruickshank, 2011) describe the meaning, of what actually does it practically mean for cities to turn into and keep on existing as “smart ones”. The paper summarizes general information on the topic of smart cities and also supports us with the highlights of a number of papers on the same topic, which were presented during “Transnational Conference on Creating Smart Cities” (Edinburgh, 2009). The paper provides a base of knowledge, which opens the meaning of cities being smart and following this conception of smart cities. This paper provides point of view of foreign scientists on the topic, forms the base of the further study. The assumptions are listed below:

• the article explains the phenomenon of smart cities;

• the paper consists information on basic features of the phenomenon;

• the paper presents reasons why the smart city concept is positive for urban development.

Russian authors are concentrated on viewing a modern city as a complex system (Boykova, Ilina and Salazkin, 2016), which require because of the appearing challenges that are faced by cities today flexible governance model that can be adjusted to shifting outer conditions. Innovative management tools are vitally required in this way, and the smart city approach is one of the most potentially efficient ones. In the paper it is concluded, that “smart city” strategies continue in many cases to rely on a narrow, “technological” approach. Such an approach presupposes that the availability alone of smart infrastructure can solve many urban problems and improve the quality of urban life. However, in contrast to the extended, comprehensive approach, it does not address many socio-economic factors and the real needs of the population. Consequently, certain targets remain largely unfulfilled. The implementation of an integrated approach implies a number of conditions, such as the ability to integrate management decisions taken at various levels and predict how changes in one system affect other systems; a focus on interdisciplinary collaboration; and an ability to deal with resistance to changes.

Another Russian paper describes the transformation of socially-economical systems at global and national scales (Vershinina, 2016), also related with this changes of urban societies are reviewed. Also, the article forms trends of city development in the conditions of industrial revolutions, which are about implementing edge-cutting technologies. Also, smart-city concept is being analyzed as one of the most popular concepts of urban development, which can suggest solutions to social, economical and ecological problems. Moreover, this article is reflecting main characteristics of smart cities, some examples are given as well. A very important feature of this very paper is that it provides an analysis of innovational development of Russia and Moscow in particular international ratings. Also, the most investment-friendly regions of Russia are reviewed (Vershinina 2016), added by a rare opinion on the perspectives for smart city development in Russia.

The trend is being really popular worldwide, and the graph below approves this tendency (Graph 3 Smart-city worldwide development strategy) (Chen, 2014):

Graph 3 Smart-city worldwide development strategy

*Source: Chen (2014)*

Moving on further, it is reasonable to start overviewing healthcare system in relation with smart cities. One of the papers by authors from China (Zhang, Liu, Zhu, Jiang and Wei, 2015) suggests a technological device for remote health monitoring system (Brown, 2001), which works constantly and in any location. Having developed multilevel architecture based on web-service and cellphone succeeded in proving stable work of the device, moreover, they interviewed people who wore this device and studied their recommendations.

Such direction of technological development is really popular: other authors earlier suggest usage of the same technology but via personal connector (Blunt, 2007). And still this direction is still developing and attracting a number of authors, with the ones, working on smartphone battery optimization for longer usage by remote care system (Alshurafa, 2014), and others, simultaneously working at special data collection server (Bangale, 2014). Authors from India suggest application of Internet of Things (Weber, 2010) concept for creating intelligent care system (Bhunia, 2014).

## 1.3 Research problem, objectives, delimitation and methodology

Existing relevant research problems are formulated in following bullet points:

* little quantity of researches on smart cities conception, applicable to Russian environment;
* absence of studies with presentation of smart city oriented projects for Russian environment;
* absence of studies with presentation of smart city oriented healthcare projects for Saint Petersburg.

The unified research problem is to be formulated in next way: absence of methodology of innovative healthcare projects implementation for Saint Petersburg environment.

Research question can be formulated as follows*:* what methods can be used while assessing implementation of a healthcare innovative project. The aim of the project lies in providing methods based on internal and external factor analysis of smart city healthcare projects implementation in Saint Petersburg. Research objectives list includes the following:

* to define country-specific factors that distinct applicability of smart city concept from foreign experience;
* to analyze application of smart city concept implementation in healthcare;
* to study cases of smart city innovative projects in healthcare both in Russia and abroad;
* to verify aspects of healthcare sector in Saint Petersburg for further smart city project implementation;
* to define external and internal factors influencing innovative projects in medical sector implementation methodology.

The research limitations cover the geographical area of application of the developed project implementation assessment: it is mainly supposed to be made to fit Saint Petersburg environment, though there is a possibility, that further on it will be possible for other Russian cities to use developed project implementation methodology on condition of specific customization. This regional specification is the main research limitation. As well, it is possible that due to availability of information needed for practical recommendations industry-specified projects might be obtained by available methods, and due to that these projects might be detailed with different level of deepening into the subject.

To sum up, research limitations are based on geographical factors and sector-related factors and to get rid of mentioned limitations it will probably require careful analysis of another region to focus on specific regional characteristics and features.

In this section the characteristic of the research category, research design, types of data to be used for completing the study, strategy of reaching research goals and methodology of primary data collection are to be presented.

 Firstly, talking about research goals and strategy to meet them is essential. This list of goals includes the following:

* to clarify and present basic features of smart city phenomenon;
* to study existing features of smart city strategy application in Russia;
* to define, what is a smart city in Russian environment;
* to study examples of innovative healthcare projects in Russia and Saint Petersburg;
* to verify aspects of healthcare sector factors in Saint Petersburg for further smart city project implementation.

In order to gain the initial research goal it is essential to use secondary data sources to get the basic information about the concept, about its main features and characteristics. This goal is covered in the first part of the study, and the best information source here is various publications and articles, mostly written by foreign authors. The examination of the stated objects is reasonable for construction the basis of the thesis. The orientation on foreign authors can be explained by the fact, that for now there are not many publications on the topic of smart cities, which come from Russian authors. Though, there is a number of significantly important works by Russian authors, which are examined, whether the perception of the concept is different in foreign environment or not. This comparison is to add some extra features for the phenomenon studied in order to provide really broad description of it.

For the second and third goals it is required to analyze existing Russian publications on the topic – secondary data is intended to be collected – in order to built a picture of what actually is a smart city in Russia alongside with detecting features of the concept application for Russian environment. This information is given in the first part of the work, since it is mostly theoretical and covers basic points, create the “base” for the further research.

The fourth goal – studying methodology of innovative healthcare projects in Russia and Saint Petersburg – can be obtained by both primary and secondary data. The primary data is to define the existing projects or strategies and smart city cases to be implemented in Russia and Saint Petersburg, which is definitely important descriptive part. Secondary data, such as structured interviews, surveys and case studies, is gathered as well. This information will be in the second and third parts of the thesis and will clarify the field of study in order to produce later on concepts of possible methodology for smart city projects implementation for Saint Petersburg environment.

The last goal is obtained via secondary data, such as structured interviews, document analysis and, surveys, since there are not mostly theoretical pieces of information, but practical research. This information is put in the last third part of the paper, the main intention of which is to make practical recommendations on smart-city projects for the chosen region.

Overall, the research category is planned to be qualitative. The reasons for the qualitative research category are the following:

* it is useful in early studies or works in relatively new fields of study;
* comprehensively written descriptions can provide rich and detailed data;
* view at the context is gained through qualitative category, which is rather advantageous in social studies (influence on individuals is also reviewed, which can be straightly associated with urban development concepts, such as smart-cities).

This all means, that the probable research category of the thesis might be mixed. The last point to be covered in this section is research design type. The thesis is intended to be descriptive or exploratory. The arguments for descriptive design are as follows: the environment, in which the subject is meant to be examined, is rather still, natural and stable. Alongside with that, descriptive types of research are usually used as sort of preliminary stage to quantitative types of research design. Also, possibility of exploratory trades of thesis might also be suitable, and the arguments or explanation for that are listed below:

* clarified initial technicalities, specifics and concerns;
* well-grounded depiction of settings being developed;
* origination of newfangled conclusions and assumptions;
* augmentation of unsettled theories.

Building up a smart city is a really hard and complicated task, as a complex approach is required, constructing the paper on how to assess internal and external environmental factors to implement a specific healthcare project to spread and research the concept of smart cities. Distinct recommendations on general environment issues are to be presented in the thesis as well, and the structure of the thesis is based on the following parts:

* Chapter 1. Description of smart city phenomenon.
* Chapter 2. Assessing environmental factors influencing implementation of innovative healthcare projects.
* Chapter 3. Methodology for assessing implementation of smart city concept-based innovative healthcare projects in Saint Petersburg.

The significance of the study can be explained with the fact, that it contains unique information, which previously has never been presented. By constructing Russian environment oriented strategies for smart city projects this significance is to be gained.

The research methodology is based on case-studies, interviews, research of professional literature (articles, publications and other resources on the topic of smart cities, urban development, etc.). Below the concept map of strategy for completion the master thesis is given, the fields are stated and for each category the appropriate methods of research will be given afterwards.

Graph 4 Master thesis completion strategy.

*Source: author.*

Building the base of the study is intended to be completed via using research of the existing papers on the topic. The papers of Russian and foreign authors are to be used, the intention is to include the basic works, which appeared in the beginning of smart-city phenomenon study, and as well contemporary works on how the application of the phenomenon is happening nowadays.

For studying the application of the smart-city approach the works mostly created by Russian authors will be used in order to provide the relevant information on whether it is possible to provide such infrastructural development projects, which are most likely to suit environment of Saint Petersburg. Here the usage of case-studies is a mandatory procedure, which is made in order to fulfill the relevance of ongoing strategy development.

Further on, interviews are collected, the goals of which are to suggest such project application assessment methodology, that is to fulfill healthcare system.

## 1.4 Saint Petersburg as a smart city: linkage between sustainable development and healthcare innovations

This section examines the relationship between smart city concepts, sustainable development and the strategy for using medical innovations. As mentioned in the work, the concept of a smart city is inextricably linked with the concept of sustainable development.

Traditionally, concept of sustainable development has been formed at the international level as a result of policy awareness and scientists of different countries, the commonality of a number of problems of mankind, the existence of interrelations between them, danger of exhausting non-renewable resources in the near future, negative trend of deteriorating people's health, and social and economic problems associated with poverty and inequality. In this context, the concept of sustainable development links primarily socio-economic and environmental areas of human activity. And here it is not a secret. that existing list of various approaches to sustainable development frameworks and concept as a whole in regard with assessment of significance of the number of features in the chain uniting people, economic situation and environmental issues supposes a variety of different ideas.

In fact, the concept of "sustainable development" is used to characterize type of economic development that ensures environmental security, reproducibility of limited resources and quality of economic growth. The most complete definition within the framework of Russian reality was suggested by V.А. Koptyug (Koptyug, 2006): "Sustainable development concept presupposes achieving a reasonable balance of the social and economic development of mankind and preservation of the environment, as well as a drastic reduction in economic disparity between developed and developing countries through both the technological process and the rationalization of consumption".

In order to assess the state of sustainable development in a specific city the number of correct indicators is needed. These indicators are based on the analysis of factors which are the turning point in characterizing quality of life for urban residence regard with economic, social and environmental features. Here, all 3 factors are closely interrelated. For instance, ecological situation in cities increasingly influences level of public health. Here problems of statistical security, aggregation of individual indicators, cross-country comparability appear while defining indicators. In this area, there is a wide range of different approaches and indicators. It is possible to select dozens of indicators, the main approaches to the development of which are to be discussed below. Talking about a unified and integrated assessment instruments for both social and economic features of urban life quality is is necessary to mention Human Development Index (HDI), which was firstly mentioned by the United Nations Development Program. This very index can be formed basing on 3 indicators: educational level, longevity of life and correspondence between GDP per capita with purchasing power parity. The choice of indicators for international comparisons is quite complex, which makes it possible to assess the ecological component of the quality of life in cities and the sustainability of their development. At present, there are many studies in the world on the development of indicators for sustainable urban development. The initial set of indicators was developed in 1998. All available approaches combine economic, environmental and social components and indicators to study the needs of present and future generations.

Russian researchers, based on participation in national projects in the sphere of sustainable development and insights from international experience, developed 24 indicators reflecting important economic, environmental and social city priorities (Bobylev, Kudryavtseva, 2014). The indicators are divided into 8 groups:

*Economic indicators:*

1. Gross fixed capital formation.

2. Coefficient of renewal of basic funds.

3. Total amount of investments on environmental protection.

*Energy efficiency:*

4. Electricity consumption as a whole.

5. Electric capacity (consumption ratio electricity to GRP).

*Transport:*

6. Passenger turnover of public transport.

7. The volume of final consumption varies types of motor fuels for environmental classes.

8. Specific weight of vehicles with age over 10 years.

*Social and institutional indicators*

9. Costs of human development of capital.

10. Share of urban population living in areas where air is highly polluted.

11. Expenditures on development of human capital.

12. Level of development of public healthcare services.

13. Proportion of urban population staying in areas with high and very high air pollution.

*“Specially protected natural territories”:*

14. Increase in the area of ​​specially protected natural areas (in % of the area of ​​cities).

15. Area of ​​green areas per capita.

*Air and climate:*

16. Emission intensity (specific emissions) (emission ratio to GRP).

17. Emissions from vehicles.

18. Emissions of suspended solids.

19. Carbon intensity.

*Water resources*

20. Water capacity (ratio of water consumption to GRP).

21. Reducing the discharge of polluted sewage.

*Waste:*

22. Volume of generation of waste from both consumption and manufacture.

23. Volume of used and neutralized production and consumption waste.

*Sound effect:*

24. Quantity of residents of noise impact zones.

 Now the connection between sustainable development, smart city concept and healthcare innovations implementation is obvious, the only fact, that requires clarifications at the moment lies in defining the difference, or, maybe, connection between medical innovations and smart city healthcare projects. It is vitally important for this work to distinguish the following: usually, innovations are meant to be implemented at micro level or from within the organization, and smart city healthcare innovations are to be more global and come from macro environment. Anyways, this differentiation has a sort of conditional character: both of the contexts are connected to implementation of some novelties in healthcare sphere, and as well both concepts will be used later on when talking about innovations in public health organizations and private medical organizations.

## Summary of chapter 1

The first chapter begins with a background for the concept of the smart city, highlighting a status of a popular concept. Later on the reasons of such concept formation are suggested, describing the growing number of city residents and their growing needs. Then possible spheres of smart city concept applicability are given in a general manner, followed by adapting aspects of smart cities for these spheres.

Every direction and every aspect of a smart city, such as smart environment, smart ecology and the rest, is carefully discussed and described. As a result of this the picture of a smart city concept appears – a combination of a number of “smart” approaches, with every one of each corresponding to a specific sphere of urban life or a group of them.

Next importance of ICT for smart city concept application evolution is being stated, integrated IT systems and smart management are named to be significant components for concepts’ existence. Later on the key idea about what actually a smart city is appears, stating, that this is an infrastructure uniting urban services.

Then the discussion on the question what is a key element making a city smart starts. Following criticism of the concept is revealed, followed by a literature review. It is continuing a “dive” into structure and inner aspects of smart city infrastructure, starting with proving rising popularity of the smart city concept. Then the discussion covering search of the main factor of a smart city takes place, followed by comparison of findings both from Russian and foreign authors, and the common things are noticeable there.

The following step is to dive deeper into the sphere of healthcare and discussion on a variety of technological solutions that are already being implemented. Research problem, objectives and delimitation, as well as research methodology and organization of the study are presented.

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# CHAPTER 2. ASSESSING ENVIRONMENTAL FACTORS INFLUENCING IMPLEMENTATION OF INNOVATIVE HEALTHCARE PROJECTS

 In this chapter the base for the development of model of healthcare innovations application in Saint Petersburg medical organizations the case of usage medical innovations is presented later followed by a presentation of innovative healthcare projects in Russia, initial conclusions on factors influencing adoption of innovations. As well, Saint Petersburg environment is briefly covered.

## 2.1 Innovations in healthcare: a case of Russia

Medical technologies, along with trends on increased energy effectualness and energy saving, nuclear, space and information technologies are priority directions for the development of any country, including the Russian Federation. Innovations touched upon the most important areas of medicine surgery, prosthetics, oncology, traumatology, obstetrics and cardiology. The fight against heart and blood vessel diseases has lately outgrown medical frame and has become a public problem, exciting the world community. High morbidity, disability and mortality from cardiovascular diseases are typical for most developed and developing countries. The death rate in Russia is one of the highest in the world. Only about 60% of premature deaths occur in the country from heart disease and circulatory system. Such negative statistics confirm the necessity of searching for rational methods of combating cardiovascular diseases and introducing the latest technology on the basis of the latest achievements of science and technology. The leading clinics of Lithuania, Sweden, Finland, Germany, France, the USA are engaged in solving such problems. It is worth noting the high innovative activity in the clinics of Israel. By introducing best practices and high technologies, Israeli specialists have managed to reduce mortality from cardiovascular diseases by two times in recent decades. One of the latest innovative developments in Israeli medicine is the unique high-tech method of stenting the Cypher stand. Cypher technology is a more advanced method of coronary stenting, consisting of the introduction of a device (stent), which gradually releases the drug substance, thereby preventing further narrowing of the vessel and significantly reducing the chance of re-occlusion. In general, Israeli medicine is considered to be one of the most advanced. Following the results of 2013, Israel took the 14th place in the world countries rating on the Innovation Index with the index of 56, having risen by 3 positions in comparison with 2012. The leader of the rating is Switzerland (66.6), while Russia occupies only 62nd place (37.2), which is 11 positions lower than in 2012. In the ranking of countries in terms of life expectancy, Israel ranks 8th (81.9 years), Japan (83.6 years) is the leader, Russia occupies 124 place (69.1 years). Undoubtedly, the quality of medical care, highly professional specialists, advanced innovative technologies for diagnosis and treatment, high-tech modern equipment and availability of healthcare services are indicative factors in the current situation in the sphere in various countries for affecting and improving life conditions for residents. Modern successes in studies of the physiology, pathophysiology of cardiovascular system have made it possible to develop new methods and principles for the prevention, diagnosis and treatment of cardiovascular diseases. The main ones are coronary artery bypass grafting, coronary angioplasty, coronary stenting, coronary angiography, electrocardiography, etc. There are also unique hybrid technologies that represent a unique combination of traditional open interventions and intravascular access for various aortic lesions. It should be noted that the introduction of innovative diagnostic and treatment technologies is increasingly covered by non-governmental medical institutions that are interested in obtaining competitive advantages. The directions of high-tech medical care in the public sector of public health are not adequately funded. In the Russian Federation mortality from circulatory system diseases during the period from 2003 to 2012 decreased on average
Thus, it can be concluded that modern medicine is a business that requires large investments in high technologies and unique equipment.

Nowadays, all participants and stakeholders of medical sector have no doubts about the special role of innovations in healthcare, which can lead to the change in approaches to diagnosis and treat diseases, provide significant improvements of patients' quality of life. While Western countries have made significant progress in the process of application of healthcare innovations, which allowed governments to give their inhabitants wide access to advanced medical technologies, this problem has not yet been solved in the Russian Federation. More than that, overwhelming majority of innovative pharmaceuticals in Russia are produced abroad, domestic production is still on extremely initial stages of development. It should as well be noted that manufacturers of medicines quite often (both in Russia and abroad), reasonably or not, use the concept of "innovativeness" as a tool to promote their products.

The problem of definition of innovation is detailed in the guidebook on the collection and analysis of data on innovations published by the UNESCO Institute for Statistics. According to this guide, innovation is the introduction of a new or significantly improved product (product or service) or process,a new marketing or organizational method into the practice of the company, the organization of the workplace or external relations. The minimum requirement for innovation is that the product, process, marketing or organizational method should be new (or significantly improved) for the company. This applies to products, processes and methods that companies create for the first time or borrow from other companies or organizations. A common property of innovation is that they must be put into practice. A new or improved product can be introduced into practice only on condition that it enters the market. New processes, marketing or organizational methods are introduced into practice when they are actually used in the company's activities.
Innovative activities are any actions of a scientific, technological, organizational, financial or commercial nature, the result of which is or should be the introduction of innovations. Some kinds of innovative activity are in themselves an innovation, others are not innovation, but are necessary for introduction of innovations. Innovation also includes research and development not directly related to the creation of a specific innovation. In pharmaceutical industry innovations can be defined as technological progress, leading to the creation of a completely new product, or to reducing costs of production or increasing the therapeutic value of an existing product.
Innovations in the pharmaceutical industry a complex phenomenon that significantly affects the public well-being and health. It includes various stakeholders (industry, patients, doctors, scientists, government, international organizations), and its influence extends not only to the pharmaceutical sector, but also to the entire economy.

Innovations can be related to different features of the produced unit, so this is a reason why one is not able to measure degree of innovativeness of drugs with just one indicator. Until now, modern medical technologies are usually divided into breakthrough drugs and analogues. If this classification is used, then to breakthrough preparation – significant innovation – it is possible to refer new agent with a specific clinical or pharmacological effect, or a new drug with the same clinical effect as existing agents, but with a different mechanism of pharmacological action. An analog preparation, or incremental (incremental efficiency) innovation is likely to be a result of a modification of molecular structure of an existing preparation that has a similar but non-identical pharmacological effect or is different in terms of absorption, metabolic rate, or clearance profile and, accordingly, quantity (The Union of Innovative Producers of Germany – VFA), characterizes the drug analogues as medicines, which are only slightly chemically altered in comparison with the precursor preparation, but provide therapeutic benefits for patients.

From VFA point of view, following drugs are innovative:

* new active substances treating diseases against which previously there were no drugs (hepatitis “A” vaccine);
* medicines with a new principle of action for diseases lacking sufficient and efficient methods of curing so far;
* new dosage forms, due to which known active substances acquire greater bioavailability and or give fewer side effects (for instance, nail polish against mycosis of nails);
* new technologies that reduce the risks associated with the active substance (clotting factors created by genetic engineering methods);
* known medicines for treatment according to new indications (for example, angiotensin-converting enzyme (ACE inhibitors) in heart failure);
* a combination of several known substances (for example, a combination of three drugs for the treatment of infection caused by Helicobacter pylori).

Innovative technologies today make a serious contribution to improving the quality of medical care, and this requires finding a rational balance between the availability of new drugs and recognizing their need, including, in particular, financing innovative activities. The declared plans of Russian government on state support of innovative ways of development of the pharmaceutical industry confirm the relevance of the progress in our country of a unified system for assessing and classifying the degree of innovation of a medical technology. Simultaneously, it is necessary to take into account the international experience proving importance of innovative medicines, and, accordingly, their adequate assessment for the healthcare system and patients. Also pay attention to the complexity of different features of novelty and detailed study of approaches to the definition of innovation in general, presented in the scientific literature. The constantly growing demand for approaches to the evaluation of medical technologies based on the analysis of evidence, as well as steadily growing number of specialists working in this field, inevitably lead to the fact that in a healthcare system based on evidence, new drugs will be rewarded in proportion to their innovativeness.

A vital feature of innovative activity of medical enterprises is the obviousness and naturalness of the main object for usage of innovations customer. This means that health in all diversity of its institutional forms and activities (and in the Russian context "behind the back" of national healthcare is the state) is the initiator of innovative activity of enterprises.

Indeed, health care, on the one hand, is an independent large sector of the economy, which has a huge impact on the social and political system, and on the other hand, it is a social sphere and a social institution, in a sense a form of human existence whose state is in a direct dependence on the overall socio-economic situation prevailing in the country.

Meanwhile, such perception of innovation conditions in the medical sector is not entirely in line with the current real processes of development of the domestic medical industry at the present stage. Moreover, in discussed sphere the formation of innovative enterprises is accompanied by the same problems and difficulties as in other spheres of domestic economy. It is legitimate to consider healthcare as a separate, full-fledged branch of the national economy of the country, which is now given a special state status. It is no coincidence that in a report at the “IV All-Russian Pirogov Congress of Physicians”, Academician Shevchenko, then Minister of Health of the Russian Federation, noted that “healthcare is a life support system, one of the most important security institutions of the nation, since it is truly the most priceless in the universe health and human life. No one can ignore the fact that almost 7% of working residents of the country works in stated sector”.

Some special place in this structure is occupied by the medical and technical industry, since the maintenance of public health and the development of domestic health care are to a large extent determined by the level of technical equipment of medical and preventive institutions. Although the share of medical devices occupies only about 10% of the total production of the medical industry, this sector is by no means inferior to the pharmaceutical industry, which is also part of the medical industry. Turning to economic categories, it is appropriate to talk about the medical and technical market (medical products market) as an integral part of the healthcare market. It is important to note here that for the analysis of the mechanism for maintaining innovations, it is important to note that the views on the market of medical devices by the leaders of the domestic industry are also of a peculiar nature. This can’t but be reflected in the system of relations with industrial enterprises. Thus, according to the head of the Licensing Department in the field of health and social development of the Federal Service for Supervision of Healthcare, the market is just a communication space, not a space for exchange. Here again it is needed to pay attention to the fact that the imperatives of the Soviet economy are still strong in the public consciousness of Russian society. It is not surprising that innovations in the medical products market are still understood as inventions, rather than commercial products of business activities.

Their products for this market are represented by domestic and foreign firms. All suppliers of medical products to the Russian market can be distinguished as follows:

* domestic manufacturers;
* large foreign manufacturers, independently represented on market in Russia;
* joint ventures that organized production in the territory of the Russian Federation;
* distribution firms that organize import and sale of machinery, as well as promotion related activities.

Manufacture of medical equipment and medical devices
(excluding service and equipment repair) is concentrated on more than 3000 enterprises and organizations of various forms of ownership and departmental affiliation. More than two-thirds of enterprises in healthcare sector are joint-stock companies of open or closed type, whose investment processes increasingly include private structures, domestic and foreign legal entities and individuals acting as direct or portfolio investors, as well as economic entities formed as commercial banks and other financial institutions that promote investment.

Number of enterprises in medical industry contains of 32 state enterprises and around 300 enterprises of the “defense” complex and other branches of the national economy, that produce about 7000 units of healthcare equipment and products. At the same time, hundreds of enterprises and organizations acting on domestic market, practically in every region of the country, represent interests of foreign producers of medical products.
The most active companies in Russia are enterprises originating from Germany, Sweden, France, the USA, Finland, the Netherlands, the countries of Southeast Asia and, of course, Chinese companies. Most companies operate here through their official dealers, whose network is growing rapidly. Many firms use a system of partner firms to help establish contacts with customers. Some international manufacturers in the sphere transferred the rights to sell their products in Russia to the large Austrian trading enterprises: “Comesa” and “Vamed”, which have been working in Russian market for a long time. Some firms organize the production of their products, mostly dental, in Russia, they open educational, commercial and clinical centers.
 In Russia market there is quite a number of firms-
intermediaries offering products of foreign production. According to some reports, only 50,6% of medical equipment market in this segment is supplied by medical equipment of foreign production. Only 9,2% of firms work with domestic equipment. And 35,6% of intermediaries promote both foreign and Russian equipment to the market and 4,6% equipment of joint manufacture. Large-scale expansion of foreign firms, in fact, is constrained by only one factor – high prices that are inaccessible to overwhelming majority of healthcare institutions in our country. But there are firms in Russian market offering costly equipment for leasing to budgetary polyclinics and private practitioners.
 Today, according to calculations (in the calculations the medical equipment of health facilities used by the Ministry of Health of the Russian Federation was used), the total cost of standard equipment for medical equipment of medical and preventive institutions in Russia is 401,66 billion rubles.
It would seem, that both the structure and the volume of the market should sufficiently satisfy needs of Russian public health. However, actual level of the equipment of treatment and prevention institutions does not exceed 58% of the normative (and most of the used instruments and equipment are morally obsolete) and is estimated at 232.96 billion rubles.

In accordance with the long-term social and economic development strategy of the Russian Federation for the period until 2020, a prerequisite raw material independence and competitiveness of the country is the transition from a raw-material development model to an innovative socio-oriented type of economy. One of the main system-forming factors determining the effective functioning of healthcare is the evolution of its infrastructure alongside with resource provision, which includes financial, technical and technological equipment on the basis of innovative approaches. The urgent need for technological innovation in the medical field at the Presidential Council for Economic Modernization and Innovative Development Russia, Minister of Health V.I. Skvortsova notes, that innovative healthcare activity is an important tool for solving urgent health problems, new methods of prevention, diagnosis, treatment and rehabilitation based on the use of new drugs and medical products, as well it includes clinical research, implementations to practical healthcare. Novelties in healthcare are the final result of the practical use of innovations (discoveries, research and development) in order to obtain economic and social effects. Innovative approach itself is to become a point of growth of the industry, it is technological improvements that will make a breakthrough in the development of domestic medicine.

## 2.2 Smart city projects in healthcare in Russia: typology, examples and perspectives

In order to study current situation with healthcare innovative projects in Russia it is necessary to take a look at both government plans on development of healthcare sector in Russia and really existing examples and make conclusions. Basing on it, it is appropriate to evaluate current environment of the field and understand connection between strategical plans of the state and existing development in healthcare sphere.

Aim of state strategy lies in creating conditions conducive to ensuring accessibility and higher quality of healthcare services provided to citizens, as well as respect for the rights of citizens in the field of healthcare. As a mechanism to achieve this aim state suggests creation of a system that unites all medical organizations, regardless of the form of ownership and departmental affiliation, functioning on the basis of unified rules and norms taking into account the specifics performed within the framework of the legislation of the Russian Federation. It is planned to solve a problem of decentralized cooperation of medical sector representatives, which doesn’t provide effective knowledge and experience interference in regard with smart city projects effective implementation alongside with forming the base for further development of healthcare sector.

Key goals, related to healthcare innovations implementation, and evolution of such system are to contain:

* accelerated innovative development of healthcare on basis of new diagnostic technologies, digital medicine and telemedicine technologies;
* development of e-health system;
* development of public-private partnership in healthcare;
* improving mechanisms of financial provision of medical care;
* improvement of control system and supervision in healthcare sphere;
* development of international relations in the field of healthcare, increasing role of the Russian Federation in global health;
* introduction of telemedicine consultations of patients, doctors and medical organizations with leading specialists from practical medical centers in the field of their activity;
* expansion of high-tech methods of treating diseases through introduction of new treatment technologies based on nuclear medicine, personalized pharmacotherapy, genome editing, the creation of a national biobank system, collections of biological materials;
* providing patients with personalized medicine services, including by identifying predispositions to diseases based on genetic testing;
* high-speed genome sequencing technologies;
* introduction of a unified state information system in the field of health care with a comprehensive analytical program for processing large amounts of information;
* introduction of information systems to support adoption of medical decisions assistance, including the use of artificial intelligence (machine learning);
* introduction of personalized accounting of actual costs of medicines, medical products and consumables in hospitals.

Presentation of key strategical fields of state-planned activity approves, that development of innovations in healthcare in Russia is required, that is why the conclusion can be made: modern innovative trends are taken into consideration both by state and existing medical institutions. After reviewing state plans on innovations implementations, it’s necessary to reflect on the really existing examples. This section presents innovative projects currently used in Russia.

Service company "Teledoctor" is a telephone clinic acting as an intermediary between patients and doctors in real clinics. In addition, staff of "Teledoctor" consists of specialists who advise and conduct electronic medical records of patients. From a financial point of view, this service is quite affordable: a single call costs from 180 rubles, an annual subscription - from 1000. The main advantage of the platform is the principle of remote work, on which it is built. The idea is that patients do not need to waste time and energy waiting for in the queues: with the help of a phone call it becomes possible to get access to the right specialist.

The company “Oriense” develops high-tech devices to help the suffering from problems with eyes: the device is attached to the chest of a blind or visually impaired person, analyzes the environment and uses a speech synthesizer to report obstacles and ways to circumvent them. The device's stereo camera helps you navigate in daylight or in bright rooms, as well as in the dark because of an infrared sensor. The project has been developing since 2006 in Saint Petersburg. Since its inception, the company has become a resident of Skolkovo, and lately took the 3rd place in the world final of the “StartUp Cup” competition.

Cloud medical CRM-system, founded in 2008 by Khabarovsk programmers Dmitry Lazutkin and Vladimir Kovalsky. Dmitry caught fire on this idea after he got to one of hospitals in Tokyo, where bureaucracy was fully replaced by computers. “Medesk” is a medical platform for clinical management aimed at increasing its effectiveness. For 6 years, this start-up has managed not only to cover a considerable territory of Russia (services were introduced in 21 regions of the country) and get approval from Dmitry Medvedev. In 2013, he was ranked in top 15 most promising projects in the world in the field of digital health by the Stanford University version, and in 2014 won the international competition of high-tech companies “The Cloud Innovation World Cup”. Now the company is scaling, and in the foreseeable future lie plans to connect to its system some clinics from Ukraine, Turkey, Brazil and Argentina.

Tomsk company "Akvelit" was founded in 2005 with support of “Bortnik Foundation”, one of few organizations supporting domestic innovative projects. “VitaVallis” is a product of this company, which is an antimicrobial sorption material and wound healing dressings. This modern alternative to antibiotics protects against infections and is suitable for all types of wounds. Principle of action of the material is based on a safe mechanism, in which the growth of microbes is suppressed within the dressing itself. Thus, the infection is destroyed not toxically, as in case of antibiotics, but physically. The innovation was developed and tested by the Institute of Strength Physics and Materials Science of the Siberian Branch of the Russian Academy of Sciences and can be widely used in surgery, dentistry and many other fields of medicine.

"My gene" is a Russian service for the analysis of human DNA. The company is engaged in determining and analyzing the composition of the human genetic chain in order to obtain the most diverse information about the body: from hereditary predisposition to certain diseases to the ethnicity of its distant ancestors. All the client needs is to pay the service fee and specialist will analyze genome, taking into account the epidemiological data on Russian territories. The project was created with the help of scientists from “Russian Academy of Sciences” and a young businessmen. That idea came to Russia from Western countries, where a similar service appeared 3 years ago.

The project "AnalysisMarket" will compare prices for laboratory tests, ECG, ultrasound and other functional studies and will suggest the best option, based on the location of the laboratory or clinic. Here a patient can read descriptions of tests and make a preliminary order, as well as learn about probable discounts. That project covers not only Russian clinics, but also Belarus, Kazakhstan and Ukraine. For users of "AnalysisMarket" all services are free.

With innovators’ efforts in Russia, organ printing on 3D printers is becoming more and more real. Project "3D Bioprinting Solutions" was created in 2013 and represents a laboratory that is engaged in design of a device with technology of three-dimensional biopressing of organs of a human body. Lately the company's specialists presented the first domestic 3D-bioprinter with its own configuration and design. The scientific leader of the team is Vladimir Mironov, a professor at the University of Virginia, author of the first publication on organ printing.

Free online service linking patients and physicians to private Moscow clinics "Infodocus" operates on the principle of online booking of air tickets. A client fills in specialization of the doctor, district of the city and desired cost of initial admission, and then selects an appropriate option, that is, is written to the doctor who works in one of the partner clinics of the project. The project is growing: every day several hundred patients are turning to the services of the company, and more than 5000 doctors from 443 clinics of Moscow are in the base of the platform. There is also the same application service for the “iPhone” and “iPad” devices.

Project “Button of life” is designed to help older people, people with disabilities in case of an accident. According to statistics, 30% of elderly people over 65 fall once a year or more often. In half the cases they can not get up and get to help themselves if no one is around. The device itself is a mobile phone with a single button, configured to call emergency calls. There is also built-in GPS-tracker, thanks to which the dispatcher automatically sees the location of the person. After determining the reason for the call, the doctor on duty contacts the necessary assistance: an ambulance, police or MES, and notifies relatives or caregivers. The project "Button of Life" became the best socially significant start-up in 2011 according to the version of several ratings, and also went to the final of the competition of start-ups from “Forbes”.

The project “iHematologist” was developed by a young company “Liandri Healthcare”, founded by Moscow students. The medical expert system “iHematologist” allows patients get a transcript of the blood test and diagnose more than 50 syndromes and diseases without leaving home. The patient simply needs to enter the results of his blood test into an electronic form on the site and receive in return the analysis made by the system automatically. The authors of the service emphasize that their project does not replace the reception of a real hematologist, but serves the purpose of getting a primary consultation.

As the examination of strategically planned development by Russian state and existing examples of innovative projects it is important to state, that innovative projects themselves are becoming more and more important, and the need for research, development and implementation is getting really obvious.

## 2.3 Defining factors influencing healthcare innovations application: background

First of all, it is vitally important to mention levels of decision-making on the introduction of new technologies. The degree of penetration and the nature of the use of new technologies in healthcare are determined by a set of decisions made by politicians, managers of medical institutions, doctors and patients. OECD experts (OECD 2005) identify next levels of decision making:

• macrolevel (decisions taken at the level of health authorities, or at the level of insurers). The main issue solved at the macro level is which products and services to admit to use in medical institutions of the country / region. For example, activities of the Federal Administration for the Control of Drugs and Food in the United States (Food and Drug Administration – FDA) – an organization responsible for the admission of new medical technologies to the market;

• meso level (decisions taken at the regional or health organizations level). At the meso level, issues related to the choice of products and services from those allowed for use on the territory of the country / region are considered, and the amount of their financing is determined. An example of decision-making at the meso level may be identification of the region's needs in a number of specialized centers of high-technology assistance based on financial constraints. At this level, decisions are made regarding the acquisition of a significant portion of new equipment (most often expensive) in a particular hospital;

• microlevel (decisions made by healthcare provider or patients). At the micro level, the choice of technologies is based on the actual needs in them. The main question is which specific technologies are to be invested alongside with resources of the medical organization for treatment of specific diseases.

It is necessary to emphasize that all 3 levels are closely interrelated: interested organizations and agencies usually interact closely. At each of the 3 levels of decision-making on introduction of new technologies, various factors are significant. The political, organizational and economic environment, as a rule, has a decisive influence on the appearance of new technologies on the market and speed of their spread. Equally important are the features of health care providers who choose from technologies admitted to the market, as well as the characteristics of patients.

Most of empirical research devoted to the spread of innovations in medicine has been conducted in recent years on microdata: questionnaires of medical institutions or qualitative interviews. Typically, the main task of researchers is to determine what factors contribute or, on the contrary, prevent the introduction of new technologies in hospitals. Most often as explanatory variables, the following characteristics were considered:

• formal and informal characteristics of the hospital (size, status, ownership, specialization, dominant behavior model, internal structure and characteristics of interaction within the organization, etc.);

• technology characteristics (cost, efficiency, risks, scope of application (narrow specialization or multi-use), etc.);

• relations with other organizations (usually scientific and educational).

In most of the studies, the analysis was conducted using the example of one country (or state), as well as a limited number of technologies (most popular are magnetic resonance tomographs and laparoscopy, and technologies related to information and communication technologies). Thus, revealed interrelations are difficult to extrapolate to other countries and other technologies.

The most complete classification of factors influencing introduction of new technologies in medical institutions was developed by K. Rai and D. Kimberly. Authors distinguish 4 groups of factors. First of them (characteristics of the external environment) includes such factors as demand (primarily patient solvency), competition, regulatory features, etc., ie, mainly factors acting at the macro level. Second group characterizes the existence of links both within the organization and between various organizations. Third group combines the characteristics of a medical organization, in fourth - features of technology.

Not all of stated factors can be quantified. To understand the nature of the relationship between agents within the organization, type of relationship and the climate in the institution, it is not enough to analyze the data of the questionnaires of hospital managers. For this, as a rule, it is necessary to conduct quality interviews with several employees of one hospital. It is not always possible to determine in advance features of further use of new technology. In general, because of inability to take into account many specific factors, empirical studies explain no more than 30% of the differences in degree of innovation.

The most important factor of external environment is demand for medical services, which depends on the level of economic development of the country or region and healthcare financing. Slade and Anderson studied the speed of innovation in different countries (Slade and Anderson, 2001). Authors used data from the OECD countries on the distribution of 5 new medical technologies between 1975 and 1995 and found a positive relationship between national income and the level of innovation. Higher-income countries introduced new medical technologies before low-income countries, but after a period of rapid innovation, differences in the speed of innovation between high- and low-income countries declined.

Found dependence can be explained by two factors. First, low-income countries are more forced to limit spending on medicine, including expensive new technologies. Secondly, medical technologies are often more evolved in more developed countries and therefore are introduced first of all in country of origin.

Positive impact of income on innovation was observed not only in developed countries. For example, in South Korea, an analysis of the data of 232 hospitals in various regions showed that in regions with a higher income per capita hospitals were more likely to purchase tomographs. Other relevant factors include relative number of physicians in the region and the percentage of people over 65 (Hahm, 2007).

Lazaro and Fitch also tried to explain differences in speed and volume of medical innovation in different countries by differences in GDP per capita and per capita spendings on health. Using linear regressions, the authors found a strong positive relationship between GDP per capita and the number of computer tomographs, magnetic resonance tomographs, linear accelerators, modern x-ray machines per capita. At the same time, there were no correlations for the other two types of medical technologies - extracorporeal wave lithotripsy and cobalt cannons. This study also failed to identify the relationship between the spread of innovation and the number of doctors per capita. In addition, much of the variation in the spread of medical technology has remained unexplained even after taking into account epidemiological factors (Lazaro and Fitch 1995).

Thus, level of economic development and volume of health financing generally determine the spread of new medical technologies, but there are other factors as well.

Level of competition and its influence on innovative activity of hospitals is being investigated in many works. Traditionally, it is believed that high competition between providers of health services promotes spread of new technologies. Empirical evidence for this statement can be found, for example, in works of Hirth (2000), Bruce and Cline (1998) and others. There is also evidence of a positive effect of competition among equipment manufacturers on the introduction of new technologies. For instance, in India, the total number of new diagnostic technologies used in hospitals has increased significantly since the liberalization of foreign trade in 1990 (Mahal 2006).

However, a high degree of competition between hospitals can lead to excessive introduction of new technologies (Hirth, 2000; Bryce and Cline, 1998). Grossman and Banks, (1998) also share a similar position on the basis of the analysis of the introduction of new technologies in California in 1983-1990. Concern about a problem of excessive introduction of technologies led to the fact that in a number of countries restrictions were imposed on introduction of new expensive medical equipment or attempts were made to influence the health facilities through public regulation. For instance, the activities of the Austrian Fund for Cooperation of Hospitals (Krankenanstalten-Zusammenarbeitsfonds - KRAZAF) were aimed at monitoring the validity of purchase of expensive medical equipment by medical sector. However, despite all efforts, the Foundation was unable to prevent the excessive distribution of expensive diagnostic equipment in hospitals, which was often purchased without taking into account the flow of patients, and solely to enhance their prestige and competitiveness (Wild, 2000).

Various social characteristics of environment, related to the specific behavior of individuals, dissemination of information, culture, role of leading specialists can significantly influence spread of new technologies. Innovation management specialists point to lack of communication as a major barrier to the introduction of new technologies in any field, and medicine is no exception (Cain and Mittman 2002; Blake 2006). In their opinion, communication is important both within the organization and outside it. An important role is played not only by the free distribution of information, but also by the channels through which the information passes (paper reports, electronic correspondence, etc.), the format of communication, distortion, etc. (Khoumbati 2006).

According to classic work of Rogers (Rogers, 1995), as well as the studies of other authors (Hillman and Schwartz, 1985), spread of innovation in health care has the character of an S-shaped curve, that is, at first a small number of first users (innovators) appear, then a stage of rapid diffusion of new technology among followers occurs, and finally, at a later date stage, they are joined by "lagging behind". For example, Ketley and Woods (1993), in analyzing the spread of thrombolytic therapy for myocardial infarction, found that its use increased several fold after the publication of the first results of the use of this therapy in authoritative medical publications.

According to Rogers, it is the position of early innovators on the effectiveness of implemented technology has the greatest impact on spread of innovation (this effect is even stronger than the conclusions obtained on the basis of evidence-based medicine). Even earlier, the role of technological innovators, opinion leaders, was discussed in the study by Greer (1985), who showed that the opinion of recognized experts who tested early on a new technology is extremely important for its further distribution. Sometimes the opinion of such leaders is even more important than official information. It is important that after this opinion has been formed and spread through informal channels of communication of the medical community, its effect is difficult to change through other channels, such as, for example, a specialized scientific literature.

Graph 5 Diffusion of innovations.

*Source:* Rogers andEverett, *1995*

In some cases, behavioral determinants can lead to the fact that distribution is not receiving the best technology. For example, E. Berndt and his co-authors analyzed the features of the distribution of new drugs on the market. The authors have shown that there are externalities from the consumption of medicines, that is, the very fact that a particular medicine has been consumed or is currently consumed, for example, by a million people, serves as an additional argument in favor of its application in the eyes of both the doctor and the patient (Appendix 1. Factors influencing the introduction of the breast cancer scanning program in the four counties of Denmark).

It is also important to pay special attention to the existence of links within the organization and between organizations. Technically, it is difficult to identify links within organizations and between organizations, and even more so, how they can influence the introduction of innovations. Such links are sometimes traced at the level of concrete examples (Appendix 2. The introduction of telemedicine in two divisions of a hospital in Hong Kong: factors of success and failure). Thanks to the analysis of this separate case, it was revealed that the presence of links between educational, scientific and medical institutions positively affects the innovative activity of hospitals. The fulfillment of the training function by the medical organization increases its interest in medical technologies. Several papers on the USA noted the positive impact of hospital ties with educational institutions on the introduction of new technologies in hospitals (OECD, 2005; Romeo, 1984). This is due to the fact that a large volume of research is being carried out in educational institutions (medical schools). Therefore, medical institutions, affiliated with educational institutions, soon learn about the benefits of new technologies, and sometimes take part in their development and (or) approbation.

 This, in particular, is confirmed in the work of Ketley and Woods (1993). The authors determined that in different regions the degree of thrombolytic therapy was significantly different depending on the participation of the districts in the experiments on its approbation.

Here’s important to mention the impact of hospital characteristics on the introduction of innovations. Firstly, formal characteristics will be discussed.

In most studies, there is a positive impact of the size of the hospital on the likelihood of introducing new technologies. This is due to the scale effect, as well as the fact that the large hospital has more resources to buy new equipment. Other formal characteristics of hospitals, such as the form of ownership, status, etc., are not always significant. For example, Romeo et al. (Romeo, 1984) found that large hospitals are more inclined to innovate, while the results for private and public hospitals did not show a significant difference. On the contrary, the results of the analysis of the distribution of magnetic resonance tomographs in 232 hospitals in South Korea (in 185 tomographs were, and in 47 - no) showed that private ownership, with other things being equal, positively influences the probability of acquiring a tomograph (Hahm, 2007). Baker (2001), devoted to the analysis of the distribution of magnetic resonance tomographs, based on various sources of information, proved that in addition to the size of the hospital, its specialization exerts a positive influence on the introduction of tomographs in the United States. In Teplensky's study (Teplensky, 1995), among the significant formal characteristics of the hospital, influencing the spread of innovation, in addition to its size, there also appeared to be status, specialization and versatility.

Interesting results were obtained by Irwin and co-authors (Irwin, 1998). In the paper, the features of introduction of new technologies were analyzed depending on the size of the hospital and the level of per capita income of households in the village. The study was conducted according to data from hospitals in the state of Florida in 1990. The dependent variable was the level of innovation that the authors assessed for each hospital. As one of the explanatory factors, the return on assets was chosen, that is, the factor that fits into the notion of decision making within the models of the first group. Initially, the authors assumed that the level of innovation will have a positive correlation with the return on assets. However, the study found that for large hospitals, the return on assets fell with the level of innovation, whereas for medium and small hospitals, the dependence was exactly what the authors of the study suggested. Thus, for large hospitals, the return on assets was not the main factor in making decisions about the introduction of new technologies, despite the fact that large hospitals were more inclined to introduce new technologies than small and medium-sized hospitals.

The informal characteristics as well regard attention. In some works, the influence of the informal characteristics of hospitals on the introduction of new technologies was described. As a rule, in these works the authors tried to take into account the features of management and decision-making in the organization. For example, a high degree of staff participation in decision-making positively affects the implementation of technologies (Teplensky, 1995). Among the significant factors positively influencing the introduction of information technology in private hospitals in Malaysia was "support from top management" (Naing, 2008).

An example of the introduction of telemedicine technologies in two offices of one hospital in Hong Kong shows that the successful implementation of the technology depends on many factors: the role of management, the interest of all personnel in the application of the new technology, the involvement of staff in decision-making, organization of trainings for employees, provision of convenient access to technology, etc.

The impact of the characteristics of technology on innovation should be mentioned as well. Numerous studies show that the extent and speed of the diffusion of technology depends on its characteristics. Thus, already mentioned earlier, Lazaro and Fitch (Lazaro and Fitch, 1995), when analyzing six new technologies, found a clear correlation between the per capita incomes of individuals in the region and the extent to which four of the six new technologies were distributed. Dependences of the distribution of the remaining two technologies on income were not found. Since the analysis for all six technologies was based on the same data, the authors suggested that the degree of distribution of these two technologies was significantly influenced by their own characteristics. Most often in applied research, the following features that affect the degree of diffusion of new technologies in medicine are noted: the clinical and economic advantages of the new technology in relation to existing technologies; risks associated with its implementation; the stage of development of new technology, as well as technological limitations on its implementation.

The clinical and economic advantages of the new technology, obviously, are factors contributing to its spread. This is both the clinical effectiveness of the new technology, and the economic impact of its implementation. The importance of these factors is confirmed, in particular, in the works already mentioned by Anderson (1990), Greenberg (2005), Thiri Naing (2008). Van der Wath and Pretorius (2008) argue that the relative advantages of technology and the risks associated with its implementation do not just affect its spread, but are key factors. It should be noted that, according to Adang and Wensing (2008), there is a gap between the short-term and long-term effectiveness of new technologies, so when implementing a new technology, it is necessary to take into account its effect, economies of scale in both short-term and in the long run.

In a study on the introduction of telemedicine in Hong Kong, the technology maturity factor was noted: more mature (proven) technology was introduced with great success. This example is consistent with the model of Rogers, explaining the stage of diffusion of new technologies based on S-crooked. Thus, depending on the time of research, even for the same technology, you can get different results. It should also be noted that for some types of innovation, there are significant technological limitations. They may be associated with special requirements for the equipment of the premises, but more often with inconsistencies in existing standards or incompatibility with existing equipment. Thus, in the study of Wong and co-authors (Wong, 2000) devoted to the spread of telecommunication technologies, it was noted that their implementation was severely hampered due to different data storage standards.

## Summary of chapter 2

Chapter 2 is a very important prerequisite to further research and to reaching the main goal: to form a model, analyzing applicability of smart city concept based healthcare innovations in Saint Petersburg medical organizations. In this chapter the base for further research as well is formed by: defined examples of healthcare innovations projects, description of Russian environment with a glance at international experience and first attempt to define environmental factors for medical organization while applying innovations.

# CHAPTER 3. METHODOLOGY FOR ASSESSING IMPLEMENTATION OF SMART CITY CONCEPT-BASED INNOVATIVE HEALTHCARE PROJECTS IN SAINT PETERSBURG

In the third chapter the final goal of the research is to be obtained: factors influencing application of healthcare innovations will be defined, followed by a finalized methodology of healthcare innovations application especially constructed for Saint Petersburg. Definition of specific both internal and external factors which are most likely to be correlated with decisions on healthcare innovations implementation is made through analysis of obtained results from a special survey and deep interviews, mentioned and presented in the section “Defining factors influencing application of healthcare innovations”, alongside with the analysis of existing theoretical data on such factors. Later on, in the section “Model of healthcare innovations application in Saint Petersburg” the previously studied theoretical data is compilated by a practical research obtained both by surveys and interviews, which gives the possibility to set up a special methodology or a model that is able to demonstrate, which factors in practical approach are to influence implementation of healthcare innovations in healthcare sector in Saint Petersburg. Obtained results are discussed in the next section of “Description of gained results”, slightly followed by the summary of chapter 3.

## 3.1 Defining Saint Petersburg environment for innovative healthcare projects application

In this section of the third chapter the factors, influencing application of medical innovations in theory are to be presented, later on followed by analysis of information from practical field: surveys and deep interviews with representatives of healthcare sector in Saint Petersburg.

In Saint Petersburg, the desire of the medical business to participate in the creation of a single e-health system has found its application - a single information space with an electronic patient card in the center. The creation of such a space is the nearest major project of digitalization of public services, which will be implemented in the city.

Informatization of medicine in Saint Petersburg began more than 20 years ago: already in the mid-1990s, the Clinical Hospital of the Russian Academy of Sciences, “Dzhanelidze” and others. The first medical information systems responded to ordinary questions: they kept records of patients, services provided, tracked the movement of the hospital bed, and so on.

In the 2000, the medical business began to digitize. At the moment, according to the head of the Association of Private Clinics of Saint Petersburg, Alexander Solonin, out of 1200 non-state medical institutions of the city the vast majority installed either software solutions developed or acquired from IT companies.

The first medical information systems medical information systems responded to ordinary questions: they kept records of patients, services provided, tracked the movement of the hospital bed, and so on.

Today, practically all aspects of the life of clinics are concentrated in medical information systems: the maintenance of medical records, the storage of research results, the management of material supplies, the movement of medicines and supplies between storage and use sites, the procurement, storage and transfusion of blood components, medical economics, reporting and analysis efficiency of the medical departments.

The introduction of electronic medical records, as well as the development of templates for patient interviews and electronic reporting, freed doctors from much of the routine work. The first and most important achievement on the way of further digitalization is the possibility to abandon paper medical records. Medical information systems allow the doctor to see the entire history of the patient's applications and his research, to filter and find the information he needs. Thus, the doctor can devote more time to the patient, instead of flipping the card in search of the latest clinical studies.

Informatization of the industry makes it possible to solve yet another common problem - to ensure the storage and accessibility of medical data.

In addition to medical information systems, multidisciplinary medical centers working with instrumental diagnostics develop radiological information systems and create repositories for visual images, the amount of which can be tens of terabytes per year. But the effort pays off - the clinical work goes to a qualitatively different level. Information on all radiation diagnostic studies, as well as their results, is stored electronically, they are linked to the patient's electronic medical record, they can be opened at any time and revised. Operative access to information is most important in oncology - to assess the effectiveness of patient treatment.

Informatization helps the medical business to solve even more complex tasks corresponding to the profile of a particular institution. Thus, large network players build federal telemedicine networks that perform several functions at once: remote branch management, telemedicine consultations, data collection. As told in the Medical Institute. Sergei Berezina, a doctor at any of the nearly 100 regional centers in 69 regions, can contact telecommunications through a consultation center to get help in interpreting the "snapshot" or writing a colleague from Saint Petersburg and minimize possible errors. On the day, the Saint Petersburg Center conducts more than 300 consultations.

Another federal network player, the laboratory diagnostics company “Helix”, has connected more than 300 own diagnostic centers to the network, as well as about a thousand state and commercial medical organizations, for which it carries out research. Using the information system of data transmission allows to minimize the processing time of analysis results - thanks to the automation of validation processes and the reduction of the human factor, the results are generated and sent to the client within 1-5 minutes.

Large network players are building federal telemedicine networks that perform several functions at once

In private clinics in Saint Petersburg there are examples of implementing solutions based on artificial intelligence. The company "Eco-Security", specializing in medical examinations, with the help of the MedSafe system of its own development, managed to establish effective control over the flow of patients. The system assesses the workload of specialists, the categories of medical examinations, the duration of medical manipulations, and builds logistics for the patient, simultaneously isolating and closing the "windows" formed due to non-attendees. As a result of optimizing the design of the documentation and the electronic queue, the total time for passing the medical examinations was reduced by 2.5-3 times compared with the average for the city.

In the clinics "Polis. Euromed Group" is developing the development of the Russian-American company “Droice Labs” - based on the analysis of "Big Data" system of support for making medical decisions, integrated with the database of electronic medical records of patients. The system gives the doctor references to clinical studies that show the effectiveness of a given drug, scientific articles, predicts certain risks to the patient, that is, acts as an evaluation mechanism. The doctor remains to weigh the alternatives based on the information received and choose the best option for the proposed appointments. errors related to the human factor.

Informatization of urban medical facilities is quite expected to take place at a more measured pace. The regional part of the Unified State Health Information System has been under construction for the fifth year, but the results so far are rather late. More than half of the clinical departments do not use medical information systems, only one third of doctors conduct electronic medical records and only one in six diagnosticians has access to the patient's electronic database.

But here it is needed to admit two indisputable facts. The first - the state represented by the city health committee - is today the only force that initiates the unification of disparate and dissimilar medical information systems into one e-health space. In February 2017, the project "Electronic Healthcare" was included in the list of priorities for Saint Petersburg. According to the federal law, from January 1, 2019 all state medical organizations of the city should join the Unified State Health Information System and transfer all information to the another electronic medical map. A year later, private blades would follow their example - on a voluntary basis.

To create a single e-health space, Saint Petersburg has chosen an integration model that unites systems of different developers based on an integration bus. This is a more flexible approach, which does not require from the industry participants a global restructuring of already implemented systems.

More than half of the clinical departments do not use medical information systems, only one third of "state" doctors conduct electronic medical records, and only one in six diagnosticians has access to the patient's electronic database.

Second fact confirming active interest of the city in the informatization of healthcare is that Saint Petersburg, unlike most regions, has already "run" the interaction of the city system with a private company by launching a joint pilot project with “Helix”. It started with the development of a single directory of laboratory tests and services “LATEUS”, based on international standards and approaches described in the “LOINC” directory. Electronic exchange of directions for laboratory research and their results was launched in 2016. Now, 90 million tests per year are processed electronically.

Although, according to the developer, technical side of integrating private and public medicine into a single digital space does not present difficulties, there still remains a number of unresolved issues. First of all, the architecture of the future Saint Petersburg e-health system is implicitly drawn. Where will the patient information be stored in a single database or clinic servers, how much should it be transferred to fulfill the needs of residents of Saint Petersburg – these questions need to be answered, and it is also necessary to develop criteria for transmitted information, which would be sufficient, but not superfluous. At the same time, it is very important that a single database "understands" various medical information systems.

Second problem is non-standardization of the formats in which medical information is currently stored. It is necessary to move to a single standard for information exchange, the use of a single, widely understandable "language", at which this information will be presented. All over the world the standard “HL7 FHIR” is used. It includes many resources that can cover the entire perimeter for the transmission of medical data.

But adaptation of medical information systems already installed in institutions to a new standard requires considerable expenses, for which not all private clinics are ready. Finally, traditionally lags behind the legislative framework, which clearly regulates the process of managing the patient's personal data.

## 3.2 Methodology of healthcare innovations application in Saint Petersburg

In this section of the thesis the main aim of the research is to be constructed: a model of assessing healthcare innovations implementation in public and private medical organizations. This model can exhaustively assess application of smart city concept based healthcare innovative projects: by that is meant the readiness and necessity of medical innovations usage in both public and private medical organizations. In order to fulfill this model a number of surveys were gathered (Appendix 3), deep interview was performed as well (Appendix 4) and case study (Appendix 1-2) was as well used to define both internal and external factors of innovations application.

After initial detection of factors influencing healthcare innovations application in the 3rd part of 2nd chapter (section 2.3 Defining factors influencing healthcare innovations application: background) it is necessary to use methodic of PEST-analysis in order to describe Saint Petersburg environment and to add significance to the formed model of assessing healthcare innovations implementation.

It is known, that to perform a PEST-analysis definition of 4 factors is required: political, economic, social and technological factors. Below these factors in regard with healthcare innovations implementation in Saint Petersburg are mentioned and briefly described:

*Political factors*

In this section the political factors will be described. First it is required to take a look at political background of Russia and Saint Petersburg in particular: legislative base and level of influence of state organizations in healthcare sector. Project of healthcare development strategy in the Russian Federation until 2025 mentions the necessity of including improvements into existing facilities and methods of work of medical institutions with patients, covering such important points as: need of emergence of electronic healthcare system required to work with patients data more effectively, start of usage of innovative technologies and medical equipment in every day operations of medical organizations. Of course this closely relates to public medical organizations since the correlation of states plans and such institutions’ operations is rather significant. But for private clinics it is as well an important trigger to develop innovations application and use it to fit customers’ needs better and, consequently, show better financial results.

*Economic factors*

Here it is important to analyze the state of Russian economy inflation rates and other descriptive information helping to form the image of the economic situation currently. It is not a secret that in the last few years Russian economic is quite controversial. GDP is starting to grow, but it cannot be characterized as sustainable, alongside with that spendings of people have grown, but incomes have fallen. This official inflation rate is below 4%. Such numbers have a very special impact on public medical organizations: This is also known as that governmental expenditures are being cut steadily, which means that support of purchase of innovative medical products or equipment from state for public health care organizations can be not that big. But for private healthcare organizations this correlation is not so obvious, since the purchase operation there rely mainly on investments of owners.

*Social factors*

In this section it is important to briefly analyze the social state of healthcare sector in Saint Petersburg in particular. Here the following issues are to be defined: sexual and age structure of the market, level of qualified staff, trends of behavior are also to be mentioned. The latest figures prove that the level of healthcare in Saint Petersburg is one of the best in Russia according to the number of indicate says as well it is important to mention that the lowest death rate in Russia is in Saint Petersburg. According to data gathered, for the moment of year 2018 Saint Petersburg is a place of life for 5.351.935 inhabitants: 45,6% of which are male residents and 54,4% are female residents. Analyzing the current trend of healthy lifestyle, which cannot be excluded from analysis, it’s important to mention that more and more people tend to care about their health more precise, which results in increased popularity of healthcare institutions.

*Technological factors*

Defining technological components requires overviewing technologies which are currently used in healthcare market in Saint Petersburg, and various ICT innovations as well. According to national “Health” project,
Saint Petersburg has been developing modernization of city healthcare system since 2005. Also, recent development of the Internet and other ICT systems has shown growing popularity of various mobile applications and digital information operations, and all these technologies are being implemented, but the level of development of medical sphere abroad is still far behind existing one in Saint Petersburg environment.

 The key “bulletpoints” on each component of the completed PEST-analysis of healthcare sector in Saint Petersburg are presented in the table below:

Table 1 PEST-analysis of healthcare sector in Saint Petersburg. *Source: author*

|  |
| --- |
| PEST-analysis |
| Political factors:* stated strategy on application of innovative healthcare equipment and technologies;
* officially stated aim of healthcare sector modernization on national level.
 | Social factors:* low death rate;
* 2nd biggest urban population in Saint Petersburg;
* growing popularity of healthy lifestyle.
 |
| Economic factors: * decrease of personal income;
* increase of prices;
* low official inflation rate.
 | Technological factors:* growing popularity of the Internet;
* existing trend of switching to modern technologies and equipment in both public and private medical organizations.
 |

Now, after completing theoretical research, surveys, case analysis and deep interview it becomes possible to complete the model for assessing internal and external environmental factors for innovative healthcare project application. Before this it is vitally important to mention the results of interview and surveys, which include practical contribution to construction of the model. Results of the surveys and interviews have shown, that, first of all, the main advantages of application of medical innovative technologies lie in possibility of effective diagnostics for the patient, appearance of new drugs and medical equipment, automated information flows, increased labor capacity and effective cooperation of healthcare sector participants.

More than that, the current state of public medical organizations’ infrastructure to application of innovative solutions in middle term period of approximately 10 years is not sophisticated. On the contrary, readiness of private medical organizations to apply novelties is assessed way better, making the option of introduction of innovations more possible. As well, in the performed surveys and interview quite a big role was given to assessing the factors of external and internal environment to medical organizations. The ideas shared show, that growing quantity of patients as a total in Saint Petersburg influences the quality of operation of medical institutions, alongside with that the current state strategy of healthcare sector development plays a very big role for public medical institutions in defining steps for application of innovative products. Other important external factors account for accessibility of innovative medical equipment suppliers in Saint Petersburg, level of national healthcare innovations development as well matters. If we talk about factors internal to medical organizations it is important to mention the strategy of medical institution development set by general management, need to cut down time costa to search and work with medical information, lack of medical personal, financial resources of the organization and comparative qualities of a medical institution with its competitors.

Also it was sorted out that the very strong power in defining development and application comes from state healthcare institutions (“Minzdrav”, etc.), more than that, almost all participants have mentioned, that private medical organizations are more likely to apply healthcare innovations in their daily operations, rather than public medical organizations. Among main constraints on the path of application of healthcare innovations are financial issues, management issues and legal issues.

In this section the assessment methodology for definition of influence of internal and external factors for implementation of smart city innovative healthcare projects is presented. It is made through combination of theoretical insights and practical information gathered from surveys (Appendix 3. Surveys) and deep interview with participant of healthcare sector in Saint Petersburg.

Table 2 Model for assessing internal and external environmental factors for innovative healthcare project application. *Source: author*

|  |
| --- |
| Model for assessing internal and external environmental factors for innovative healthcare project application |
| Type of project |
| Technological innovations | Pharmaceutical innovations | Organizational innovations | Information systems innovations |
| External factors | Internal factors |
| * Demand for medical services
* Level of competition
* Social characteristics of the environment
* Connection between various medical institutions
* State strategy on medical innovations implementation
* Availability of information exchange base for innovations implementators and specialists
 | * Level of communications inside medical institution
* Role of the managerial block of the medical institution
* Financial assets available for innovations implementation
* Interest of personnel in innovations implementation
* Availability of training programs for personnel on innovations adoption and operations
 |
| Recommendations for assessment: |
| Assessment of economic effectiveness of investments into innovative facilities |
| Assessment of effectiveness of strategical decision-making process |
| Assessment of ability to adopt medical technological solutions |

## 3.3 Conclusion: description of gained results and recommendations

In this finalizing part of the third chapter obtained results will be discussed and the final conclusions are to be set up.

Before presenting the main conclusions of the conducted qualitative research it is necessary to notice, that interference with data exchange between innovation activity applicators is crucial for innovations spread, basically, in any sphere, and, obviously, medical sector is not the exception.
 Analysis of collected surveys alongside with interviews conducted by interaction with participants of the administrative block of healthcare institutions in Saint Petersburg showed the following: today Russian healthcare workers don’t have enough possibilities for provided professional communication inside their sphere. Basically, most of the workers of healthcare institutions in Russia and in Saint Petersburg in particular do not have enough resources and time to take part in conferences, seminars and other events, which directly relates to international events. Moreover, the majority of doctors do not keep on going on with scientific work. Also, most doctors do not have access to international medical journals, and often there is no way to read them in a foreign language if such access was available. These and other triggers are the reason of the fact, that most of the doctors don’t have enough data about new medical technologies, innovative treatment approaches and even appropriate ways of communication with patients and their relatives.
 It is logical to sum up here, that the main preliminary outcome comes up in current task of public medical policy – to promote development of various networks facilitating communication between healthcare workers, patients, manufacturers and other participants of the industry. In order to solve this problem, some possibilities regarding recommendations to state institutions, responsible for healthcare sector control can be used, such as:

* creation of funds that provide grants on a competitive basis for the implementation of joint projects, bringing together participants from healthcare sector scientific organizations, patients and producers;
* stimulating participation of industry specialists in both national and international conferences with reports on scientific activities through provision of travel grants. This is especially crucial for young doctors, who have limited access relevant financial resources of the medical institutions, which they work for;
* supporting scientific internships in leading Russian and international medical institutions; encouraging interregional exchange of experience by inviting doctors from one region to another in order to provide consultations alongside with the transfer of experience;
* financing of membership in international medical organizations, providing access to international journals and international database on of healthcare;
* financing creation of sites to provide communication, exchange of resources between patients, doctors and manufacturers, including the Internet.

The analysis of foreign experience and Russian practice of introducing new technologies, oriented on Saint Petersburg region in healthcare organizations provides the possibility to draw the final conclusions. Firstly, the processes of introduction of new technologies in medical organizations in countries with developed market economies are characterized by the use of different criteria and procedures for the adoption of such investment decisions. For the description in the foreign literature different models are proposed, which make up three large groups in total. The first group - the models for making financial and economic decisions - suggests that the main criterion in assessing new technologies is the economic effectiveness of the respective investments. The second group, the models of strategic and institutional decision-making, is based on the premise that the main criterion in the assessment of technologies is their ability to enhance the prestige of the medical organization in order to strengthen the competitive position, achieve technological superiority and, on this basis, obtain material benefits in the future. The third group, the models for the adoption of medical and technological solutions, suggests that clinical efficiency is the main criterion for assessing technology by hospitals. Below the table summarizing these ideas on mentioned approaches is presented:

Table 3 Models for decision making. *Source: author*

|  |  |
| --- | --- |
| *Approach* | *Focus* |
| Models for making financial and economic decisions | the economic effectiveness of the respective investments into innovative facilities |
| Models of strategic and institutional decision-making | ability to enhance the prestige of the medical organization in order to strengthen the competitive position, achieve technological superiority and, on this basis, gain benefits in the future |
| Models for the adoption of medical and technological solutions | clinical efficiency is the main criterion for assessing technology by hospitals |

The results of benchmarking research of foreign practices show, that none of the three groups of models can be considered comprehensive or complete: the factors underlying each of them may be dominant, depending on the circumstances. Models for making financial and economic decisions are most often used when replacing or purchasing an additional volume of medical equipment already in use in the treatment and diagnostic departments of the hospital. Models of decision-making on the basis of the criterion of increasing the prestige of a medical organization and obtaining from this benefit in the future are used in evaluating technologies that have a significant impact on the prospects for the development of the clinic. In cases when the medical organization faces the need to choose between the quantity and quality of services (between the volume of services provided and the intensity of treatment) for given financial constraints, the behavior of the clinics is described using models of making medical and technological decisions: first of all, the clinical effects of the compared technologies.

The spread of new medical technologies is determined by the factors acting at the macro and meso levels (disposable incomes of citizens, peculiarities of the policy of cost recovery, level of competition, behavioral determinants, etc.), and also at the micro level (characteristics of hospitals, technologies, and stability of network links). Also, it can be concluded, that the spread of new technologies is mostly often positively influenced by: high incomes of citizens, stimulating mechanisms to compensate for medical care costs and new equipment, high level of competition between service providers, size of medical organization, involvement of staff in decision-making, affiliation of clinics with educational and scientific institutions.

In countries with developed market economies, the state is actively involved in the process of introducing new technologies into healthcare. At the same time, both state and private medical organizations are in the sphere of state attention. For the latter, the role of the state is not limited only to regulation. Private medical organizations in many countries receive funding from the state for the introduction of new technologies.

As well, in the practice of developed countries, an important place is assigned to planning the process of introducing new technologies. Three main mechanisms of state participation in planning the introduction of new technologies in medical institutions can be identified.

• Central and regional authorities directly plan and finance the procurement of medical equipment (and technology) for the needs of the medical institutions under their jurisdiction.

• The state regulates the process of acquiring new equipment, establishing rules for medical organizations of various forms of ownership and different degrees of autonomy.

• The state reimburses the cost of providing services using this or that technology in both public and private medical institutions.

In recent years, there has been a move towards decentralization of state regulation of the planning and financing process for the introduction of new technologies.

An increasingly important factor affecting the spread of innovation in Western countries is the quantitative assessment of the effectiveness of new medical technologies. Its role depends on the quality of research on the cost-effectiveness of alternative technologies, their timeliness, and the organization of the decision-making process at different levels.

In addition to the administrative regulation and direct financing of the introduction of new medical technologies, states in developed market economies use various tools to stimulate and indirectly support such implementation. In many countries, universal tools for supporting the introduction of new technologies are being applied, extending to all sectors of the economy, including health care. These are tax incentives, the promotion of public-private partnerships, the support of special infrastructural organizations that promote innovation, etc. Universal measures to support innovation are more likely to be claimed by private medical organizations, since they have greater autonomy in decision-making.

The process of introducing new medical technologies is not always organized in the best way, even in countries with developed market economies. As a result, there may be losses in efficiency associated with excessive, or, conversely, inadequate acquisition of new technologies, the choice is not the best (in terms of economic and clinical indicators) of medical equipment, the weak use of the capabilities of acquired technologies. These listed problems take place in countries with different levels of economic development, but in Russia the problems of the effectiveness of introducing new medical technologies are particularly acute. In Russia the introduction of new technologies into medical institutions is usually initiated by the institutions themselves, but the main subjects of the decision-making are federal and regional authorities that purchase medical equipment for health facilities. There are no big differences between the regions in the degree of such centralization and in the opportunities provided by the health facilities to make independent decisions on the purchase of new equipment, including at the expense of the funds they earned from providing paid services.

Criteria for the selection of medical technologies are different for health authorities and for medical institutions. Declared in the decision to purchase equipment, the priorities of the regional health authorities reflect mainly the establishment of clinical effectiveness (in its broadest sense - with reference to the system of medical institutions in the region as a whole). At the same time, the centralization at the regional level of procurement of medical equipment for health facilities creates the prerequisites for the interest of the decision-makers in rent-seeking behavior, in which the criteria for evaluating the applications of health facilities and the choice of purchased equipment are deformed. The main interest in this is the size of the "rollback" when buying a particular equipment.

In order to describe the behavior of public health facilities in Russia when choosing new medical equipment purchased from budgetary funds, it is possible to use two types of models identified in the analysis of medical organizations in the West: the model for adopting strategic and institutional solutions and the model for adopting financial and economic solutions. When choosing technologies and forming applications for new equipment at the institution level, there is an interest in increasing the prestige of health facilities and getting benefits from it in the future. But unlike Western clinics, the interests of Russian health facilities and their doctors focus on the opportunities for subsequent income growth not from all activities, but only a part of it - from providing paid medical services to the population, as well as receiving informal payments from patients. In applications from the health facility, one seeks to purchase expensive equipment that improves the image of the institution and is intended to be used to a large extent to provide paid medical services.

In cases where health facilities independently buy new equipment at the expense of their income from paid medical services, their behavior more often corresponds to models for making financial and economic decisions. But at the same time, unlike Western clinics, a narrow range of economic effects is considered (expansion of services, attraction of additional patients, volume of paid services) and does not take into account such indicators as return on equipment, payback period, price potential, market size.

There are significant differences in the organization of the decision-making process on the introduction of new technologies by private and public medical organizations. Contrary to expectations, managers of private clinics, unlike the main doctors of public medical institutions, have a greater degree of freedom in preparing and deciding on the choice of technologies for implementation under the framework of economic control by the owner.

Unlike public health facilities, private clinics focus more on clinical effectiveness, the quality of the provision of medical services (in order to gain the confidence of patients) than on financial and economic indicators or prestige. However, economic factors and influence on prestige are taken into account, but to a lesser extent. The understanding of economic interest in private clinics is consistent with global practice and includes comprehensive assessments of all costs and benefits associated with the introduction of new technology.

All in all, the important issues related to the process of introducing new technologies in Russian medical institutions include the following.

* Low clinical and economic efficiency of procurement of new medical equipment for health facilities

Since the technical re-equipment of medical institutions is carried out mainly through centralized equipment supplies, the heads of medical institutions are interested in the excessive receipt of equipment and are eager to stock up on new equipment for future use. In turn, health authorities that make procurement decisions often inadequately take into account the need for appropriate services and the ability of health facilities to effectively use the equipment they supply. As a result, situations are repeated when equipment of excessive capacity or productivity is purchased, which is not fully claimed.

* Inconsistency in planning the introduction of medical technologies and financing of high-tech medical care

Decisions on equipping hospitals with high-tech medical care equipment are often made without linking with the planning of current budget funding for such assistance.

* Lack of tools for a comprehensive assessment of the financial and economic efficiency of equipment purchased for the needs of state health facilities
* Low level of awareness of doctors working in public health facilities, about new technologies in comparison with their western colleagues and with Russian doctors, working in private clinics.
* A very small proportion of doctors - specialists who own modern methods of treatment used in developed countries and who have already become "ordinary". According to expert estimates, this proportion is less than 1% of the medical experts.
* The ineffectiveness of procurement procedures for equipment, expressed in suboptimal terms, excessively complex reporting procedures, the existence of monopoly structures engaged in procurement, and so on.
* Problems with the use of existing equipment: downtime due to the lack of supplies, funds for repairs, qualified doctors, etc.
* Low level of use of the potential of public-private partnership in the health sector.

The main problem of organizing the introduction of new technologies in Russian health facilities is that existing positions and, accordingly, the interests of key decision-makers on the introduction of new technologies (health authorities, health facility managers, doctors) do not and can not ensure a stable orientation of the innovation process on increase their clinical and economic efficiency.

Health authorities that monopolized the procurement of new equipment at the expense of budgetary funds demonstrate an interest in increasing clinical efficiency and, at the same time, are informally interested in extracting rent from their position. The question of assessing the clinical and economic effectiveness of these interests is not answered. Possible alternatives are not compared in terms of the ratio of the price of equipment to the clinical results achieved.

Heads of health facilities and doctors working in them are interested in receiving from the state of equipment for the sake of increasing the prestige of health facilities and the subsequent monetization of this prestige in the form of legal and informal payments from patients. The price of the equipment also does not correlate with clinical effects.

Thus, the existing system of decision-making on the introduction of new medical technologies is working to replicate the costly nature of this process - costly for the state and for the population. This system is not able to respond to the challenges that health care is facing in accelerating technological changes in medicine, increasing the cost of new technologies and treating the diseases of an aging population.

These challenges require increasing the efficiency of using a growing flow of resources into the industry. And today's system of procurement of new equipment at best will provide an increase in clinical efficacy, but not clinico-economic, and will work to increase the costs of the state, incommensurable with increasing clinical effectiveness.

In order to meet these challenges, it is necessary to develop insurance methods for financing healthcare, since non-insurance methods of financing (payment by the population to the cashier and to doctors after the provision of services) increase the burden of such expenditures for family budgets. However, staff of medical institutions is interested in the growth of direct patient payments and are able to increase such payments on a scale incommensurable with the growth of the clinical effectiveness of the implemented technologies, using the introduction of new technologies and the situation of information asymmetry between them and patients. The costly organization of the innovation process makes domestic health care increasingly expensive for the state and for the population.

As the main directions for improving the implementation of new medical technologies in Russian medical organizations, the following recommendations are proposed.

• To drastically reduce the possibility of sacrificing efficiency requirements to other interests, it is necessary to change the very configuration of the positions of health authorities and health facilities in the process of introducing new medical technologies. It is necessary to delegate the authority to purchase medical equipment by the health facility itself. The function of the management bodies should be the approval of programs for the development of specific health facilities.

• It is necessary to change the general conditions of management of medical institutions, bringing them closer to the economic conditions of private clinics (the sequential transition to single-channel financing of their activities from public sources in accordance with the achieved results of their work, increasing economic responsibility for these results). Changes in business conditions, approval of development programs and monitoring of their implementation should become the main mechanisms for switching the interests of health facilities when introducing medical technologies to clinical and economic efficiency and narrowing for themselves the possibilities of rent-seeking behavior.

• Eliminate excessive state regulation of introduction and use of new technologies (limitation and simplification of reporting forms, revision of sanitary norms and rules, bringing them in line with the level of modern medical technologies, etc.). To avoid the emergence of uncontrolled zones, it is necessary to change the principles of organization of control over the quality of medical care and the introduction of new technologies, providing for the transfer of a significant part of state control to public organizations (associations of medical workers and patients).

• Implement procedures for assessing medical technologies in the planning of procurement of medical equipment.

• Improve procedures for the procurement of new medical equipment, including the establishment of medical equipment registers; approval of standards for the provision of medical equipment, increase the transparency of all stages of deciding on the purchase of new equipment, etc., which will allow more precise determination of the parameters necessary for the equipment institutions, plan appropriate purchases and reduce the opportunities for corrupt transactions with suppliers.

• To develop practice of public-private partnership in healthcare, including the creation of conditions for the participation of private organizations in the system of medical care, the transfer of part of the capacity of medical institutions for long-term rent, concession to private management companies.

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# APPENDIX 1.

Factors influencing the introduction of the breast cancer scanning program in the four counties of Denmark (case-study).

A mammogram for scanning breast cancer among women aged 50-69 years twice a year was first introduced in practice in Copenhagen in 1991. In 2006, only five of the 14 districts and two municipalities of national importance introduced a regular mammogram, while most of the districts abstained from doing so. In order to determine why some districts have introduced mammography and others have not, a special study was conducted in the four districts (two of whom introduced the mammography procedure and two did not implement it) between 1991 and 2006. It included the interviewing of persons who participated in the decision on this issue.

The role of the following factors was analyzed:

* interpretation and use of scientific evidence of safety and cost-effective technology;
* issues of ethics and moral values ​​associated with mammography, for example, the issue of erroneous positive and negative results of scanning; diversion of resources from the treatment of patients to the scan of healthy;
* the role of the State Department's recommendations on technology at different times, changing from neutral to direct recommendations to implement the program;
* practical issues, including the availability of financial resources and the necessary staff, in particular radiologists;
* the presence of local political conditions, with an emphasis on the level of agreement or disagreement at the political level;
* role of district officials and doctors;
* other factors, including the presence or absence of informal leaders and interest groups.

As a result, the most important factors were: the attitude of medical workers and district officials to clinical evidence of the safety and effectiveness of mammography, ethical issues, the recommendations of the State Department of Health and the availability of resources. The strong negative impact of these factors led to the rejection of the introduction of scanning in the districts of Aarhus and Vejle.

In Funen County, which implemented the scan, all these factors had a positive impact, and in West Zealand County, the availability of resources and the promise of state support played a decisive role in making a positive decision about the introduction of technology. In addition, in all four districts the opinion of informal leaders had a significant impact on the decision-making process, while state recommendations, even at the legislative level, played a lesser role.

*Source:* Hersch, J., Jansen, J., Irwig, L., Barratt, A., Thornton H. 2011. How do we achieve informed choice for women considering breast screening? Preventive Medicine 53 (3): 144-150.

APPENDIX 2.

**The introduction of telemedicine in two divisions of a hospital in Hong Kong: factors of success and failure**

In one of the hospitals in Hong Kong (a large regional medical center that provides inpatient and outpatient care, emergency services to the population, and consultations with ordinary hospitals in the district), telemedicine programs were launched in two departments simultaneously. The two programs were very similar in purpose (both related to medical images) and the technology being introduced. Nevertheless, the results of the two programs differ significantly: in the department of neurosurgery the program has been successfully realized for several years, whereas in the radiology department it was abandoned after some time. Such different results were largely related to the management of the process of implementation and dissemination of technology in two offices.

When analyzing the practice of introducing telemedicine in the radiology department, it was found that initially the attitude of radiologists to technology was not the same, some employees did not see any benefits in using this technology. The initiator of the program was one of the radiologists, and with the installation of the technology only the opinion of the head of the department was taken into account, while the radiologists were practically not involved in the decision-making process. Moreover, the head of the department, although he was not against the introduction of the system, was skeptical about her role in the work of the department. He expressed his doubts to other radiologists about the reliability of the technology, the additional administrative burden, and so on. No special measures were taken to form a positive attitude toward technology in the department. Issues such as the location of equipment installation, technology financing and the choice of connection lines, were not discussed.

In addition, the technology was still "raw" and developed in parallel with the installation process. The office transferred the functions of providing the necessary technical and financial support to an external organization that faced a number of unexpected technical problems with respect to the preservation of images, their transmission, display, etc. Some problems arose from omissions in assessing the compatibility of technology and the equipment available in the department , as well as the infrastructure of the connected hospitals.

After completion, the system gave sufficient visual resolution and allowed to do the necessary operations, create a snapshot archive, and as a whole could be effectively used. However, from the point of view of using the technology, its distribution was not effective. This was due to several factors. For example, the incentive for using the system was selective and limited. The system significantly increased the efficiency of the provision of services by the department, but only one of the radiologists, its initiator, benefited. Some radiologists considered the system a stranger, because the support was handled by an outside organization. Many radiologists were not well acquainted with the system and did not have the practice of working with it. Also, the system was installed in the workplace of one of the radiologists, which was inconvenient for other doctors.

After 18 months, the initiator of the implementation of the system resigned, and the management of the department refused to continue financing the technology. Management of the department of neurosurgery was based on team interaction and the search for consensus. The initiator of the introduction of telemedicine was the head of the department. However, he provided enough time for his colleagues to study, evaluate and adapt to alternative methods of providing available services. He arranged meetings of neurosurgeons with colleagues who already used telemedicine, studied the potential limitations of its use, analyzed the existing technological base of the department, the infrastructure and the resources of the organization. In addition, he began to plan in advance the solution of such managerial problems as the placement of equipment, financial resources and the choice of the communication channel.

The head of the department discussed personally with each neurosurgeon their assessments and doubts about telemedicine. The potential of the technology and its impact on the work of individual neurosurgeons were analyzed. The choice of technology supplier was made after a serious market analysis, as a result, a system different from that used in the radiology department was introduced. In the process of deciding on the choice of a specific technology, many staff members also participated. There were meetings where neurosurgeons openly discussed and evaluated the system. A positive decision was taken unanimously. Collective was also the search for a source of financing the implementation and operation of the system and the choice of the communication channel.

The installation of telemedicine in the neurosurgery department was quick for several reasons. First, the technology was already mature and did not need a significant improvement. One of the neurosurgeons was appointed responsible for the introduction of technology, which greatly increased the communication and coordination between neurosurgeons, management and the supplier of technology. Many neurosurgeons participated in the process of evaluating technology and its refinement and as a result got acquainted with the system and its work.

The spread of technology in the department of neurosurgery was effective. Neurosurgeons used the system on a daily basis to respond to requests for consultations and to decide on the transfer of patients from a general hospital ward. The head of the department clearly indicated that he supports and highly appreciates the regular use of the system. Access to the system was convenient: it was located in a common diagnostic room, and it was decided to install all future equipment for telemedicine. In addition, the system was also installed on laptops of neurosurgeons to provide access to it from home if it is necessary to provide urgent advice.

*Source:* Sheng, O., Hu L., Jen-Hwa, P. 1998. Adoption and Diffusion of Telemedicine Technology in Health Care Organizations: A Comparative Case Study in Hong Kong. Journal of Organizational Computing and Electronic Commerce 8 (4): 247–275.

# APPENDIX 3.

Survey form

Survey (19 respondents):

*Innovations at healthcare institutions in Saint Petersburg*

|  |  |
| --- | --- |
| Please, write the company you work for |  |
| Please, write your job position |  |

*Innovations in medicine are new and competitive technologies for the production and use of medicines and diagnostic medical research, as well as the latest methods of treating patients, technologies for processing large amounts of medical data*

1. Rank from 1 to 5 the advantages of applying innovative technologies in medical institutions, where 1 is the highest importance, 5 is the least significant:

|  |  |
| --- | --- |
| *Advantages* | *Relevance* |
| The possibility of effective diagnosis of the patient (speed of diagnosis, increased accuracy of diagnosis, etc.) |  |
| Automated information flows (provide speed of work with patients) |  |
| The emergence of new methods of treatment (the creation of new drugs, the use of artificial intelligence, etc.) |  |
| Effective interdepartmental and interdisciplinary interaction of industry participants |  |
| Increase in labor productivity while working with medical documents |  |

2. Indicate what innovations are currently applied in your medical organization (open question):

3. Indicate what innovations are currently applied at the level of the health authorities (open question):

4. Assess the readiness of the existing infrastructure of budgetary medical institutions to implement innovative solutions in the medium-term period of 7-10 years (please circle accordingly, where +5 is the maximum value and -5 is the minimum):

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| -5 | -4 | -3 | -2 | -1 | 0 | +1 | +2 | +3 | +4 | +5 |

5. Assess the readiness of the existing infrastructure of private medical institutions to implement innovative solutions in the medium-term period of 7-10 years (please circle accordingly +5 - maximum and -5 minimum):

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| -5 | -4 | -3 | -2 | -1 | 0 | +1 | +2 | +3 | +4 | +5 |

1. In your opinion, what factors of the external environment most strongly influence the use of innovations in medical institutions in Saint Petersburg (please rank the significance level, where 1 is the highest, 5 is the least important):

|  |  |
| --- | --- |
| *Environmental factors* | *Relevance* |
| The growing burden on medical institutions in the Russian Federation |  |
| The frequency of innovation in the medical sphere in the Russian Federation |  |
| Availability of domestic innovative medical developments |  |
| Representation of "suppliers" of medical innovation technologies in the Russian market |  |
| The current strategy for the development of the medical sphere, defined by the Ministry of Health of the Russian Federation |  |

1. In your opinion, what factors of the internal environment most strongly influence the application of innovations in medical institutions in Saint Petersburg (please rank the significance level, where 1 is the highest significance, 5 is the least significant):

|  |  |
| --- | --- |
| *Factors of the internal environment* | *Relevance* |
| Lack of medical staff (need for optimization of activities) |  |
| The need to reduce the time spent searching for and processing medical information |  |
| Available financial resources of a medical institution |  |
| The development strategy of the medical institution, determined by the administrative apparatus |  |
| The current situation of the medical institution in comparison with similar (size, number of employees, etc.) |  |

1. In your opinion, what are the additional factors that influence the implementation of innovative projects in medical institutions in Saint Petersburg (open question):
2. In your opinion, which health facilities are most likely and more likely to use innovative technologies under current circumstances (please circle 1 option):
* Private-owned
* State-owned
1. In your opinion, what restrictions can arise in the process of introduction / application of innovative technologies in medical institutions in Saint Petersburg (open question):
2. Indicate the development and introduction of which directions of innovations in medicine are potentially promising for Saint Petersburg (open-ended question):

# APPENDIX 4.

Personal interview questions

1. What kind of innovations in healthcare is used more frequently than others at the moment?
2. In your opinion, which innovations are needed to be implemented in healthcare?
3. How to launch the mechanisms of innovation development? What are the driving forces, mechanisms need to be involved?
4. How do you evaluate the level of innovation development in healthcare?
5. How should the production chain be organized from innovative ideas to innovative products? What links in the chain are missing?
6. Have you noticed any legal difficulties in introducing innovations with executive bodies of state power?
7. What measures need to be taken to create innovative products in healthcare invented and made in Russia?
8. Who specifically should form a request for innovation in healthcare? What should be the content of the request?
9. How are innovations in healthcare supported at the moment?
10. Evaluate the readiness of the existing infrastructure of budgetary medical facilities to implement innovative solutions in the short term.
11. How do you assess the experience of innovation implementation in healthcare in St. Petersburg over the past 7-10 years?
12. Does the deficit of medical personnel affect the use of innovations in medical facilities in St. Petersburg?
13. Evaluate the readiness of the existing infrastructure of budgetary medical facilities to implement innovative solutions in the long term.
14. Does the development strategy of the medical facility influence the application of innovations in healthcare in St. Petersburg?
15. Evaluate the readiness of the existing infrastructure of private medical facilities to implement innovative solutions in the short term.
16. What administrative barriers can arise in the process of introducing innovations in the medical institutions of St. Petersburg?
17. Evaluate the readiness of the existing infrastructure of private medical institutions to implement innovative solutions in the long term.
18. Does the presence of Russian innovative medical developments affect the use of innovations in medical facilities in St. Petersburg?
19. What is the most successful innovation in healthcare was applied in a medical facility in St. Petersburg?