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SCENARIO APPROACH TO BUILDING PREDICTIVE MODELS FOR THE DEVELOPMENT OF REGIONAL HEALTH SYSTEMS

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The article is devoted to the problems of scenario modeling in relation to solving a number of problems of managing the health care system of the Perm Territory, which in recent years has attracted attention of the development of a number of promising projects to develop this industry, to expand the availability of medical services and to improve the level of medical care for the population. Any good-quality project must be directly linked not only to the future periods of its implementation, but also be scientifically justified in terms of insuring all kinds of risks and threats that will stand in the way of the successful completion of the project. Therefore, recently all kinds of projects, programs and plans are often developed using the so-called scenario approach. Several options for the development of events with this approach are offered to the appropriate circle of leaders or the power structure for the subsequent adoption of an appropriate management decision. The authors of the article consider the main provisions and principles of the scenario approach using the example of the development of the health care system of a particular subject of the federation, which makes the material proposed for consideration very relevant. The authors also define, as they see it, the main result of improving the industry in the form of a target and a national goal: the expected (future) life expectancy of the population of the study area. This socio-economic indicator, which has all the signs of fatefulness, is considered by the authors to be a priority analytical indicator of the level and quality of an effective life of a Russian. The latter determines the purpose of this study. The authors consider the construction of dynamic multivariate models of industry development options for a period of up to three years to be an efficient tool for analyzing and forecasting this indicator, which is presented in the article in the form of five simultaneous equations of multiple regressions. The results of this construction are continued by discussion, and the article ends with a list of conclusions.

Keywords: management decision, forecast, plan, scenario, risk, threat, probability, national economy, health care system, forthcoming (expected) life expectancy, econometric model, statistical estimation, random component

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СЦЕНАРНЫЙ ПОДХОД К ПОСТРОЕНИЮ ПРОГНОЗНЫХ МОДЕЛЕЙ РАЗВИТИЯ РЕГИОНАЛЬНЫХ СИСТЕМ ЗДРАВООХРАНЕНИЯ

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Статья посвящена проблемам сценарного моделирования применительно к решениям ряд-да задач управления системой здравоохранения Пермского края, который в последние годы обратил на себя внимание разработкой ряда перспективных проектов по развитию данной отрасли, по расширению доступности медицинских услуг и по повышению уровня медицинского обслуживания населения. Поскольку любой добротный проект должен иметь непосредственную привязку не только к будущим периодам своей реализации, но и быть научно обоснованным с точки зрения страхования всевозможных рисков и угроз, которые встанут на пути успешного завершения проекта, в последнее время всяческие проекты, программы и планы часто разрабатываются с использованием так называемого сценарного подхода. Несколько вариантов развития событий при таком подходе предлагаются соответствующему кругу руководителей или властной структуре для последующего принятия надлежащего управленческого решения. Авторы статьи рассматривают основные положения и принципы применения сценарного подхода на примере развития системы здравоохранения конкретного субъекта федерации, что делает предлагаемый к рассмотрению материал весьма актуальным. Авторы же и определяют, как им представляется, главный результат совершенствования отрасли в виде целевого показателя и национальной цели – ожидаемой (предстоящей) продолжительности жизни населения исследуемой территории. Этот социально-экономический показатель, обладающий всеми признакам судьбоносности, авторы считают приоритетным аналитическим индикатором уровня и качества эффективной жизни россиянина. Последнее определяет цель настоящего исследования. Работоспособным инструментом анализа и прогноза этого индикатора авторы считают построение динамических многофакторных моделей вариантов развития отрасли на период до трёх лет, что в статье и приводится в форме пяти одновременных уравнений множественных регрессий. Результаты подобного построения продолжены обсуждением, а статья завершается выводами. Ключевые слова: управленческое решение, прогноз, план, сценарий, риск, угроза, вероятность, национальная экономика, система здравоохранения, предстоящая (ожидаемая) продолжительность жизни, эконометрическая модель, статистическое оценивание, случайная составляющая.

Ключевые слова: управленческое решение, прогноз, план, сценарий, риск, угроза, вероятность, национальная экономика, система здравоохранения, предстоящая (ожидаемая) продолжительность жизни, эконометрическая модель, статистическое оценивание, случайная составляющая

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Introduction

The mechanism for managing the national health care system, which developed during the period of a transitional market economy and has characteristic recognizable features of the organizational and economic order, suffers from noticeable systemic deficiencies and contains significant internal contradictions. Most of the contradictions and shortcomings noticed in the vast scientific literature were recorded and analyzed in detail, while the scientific community and society found a more or less stable agreement on the ways to overcome them.

The managerial decisions made by the power structures of different levels in recent years as part of the modernization of the industry meet with a serious misunderstanding of the general population, and they generate heated discussions among specialists. And all this provided that all stakeholders in the modernization process want a radical improvement in the health of the Russian population and are looking, both separately and together, for formulations of specific upcoming managerial decisions and ways to regulate the industry in order to truly improve it.

In the regulation of health care, the state determines the goal, objectives, directions, principles of state policy, sets the amount of budget financing and tries to create a system of efficient regulators. The objects of the health care system, which are regulated by the state in one way or another, include all institutions

and subordinate health services. The main body for achieving goals and solving problems in the health sector is the Ministry of Health of the Russian Federation (MoH).

This authority is also entrusted with the task of forming state policy and monitoring its implementation, especially since the allocated financial content of the industry and contribution to GDP are very significant. Thus, the share of Russian healthcare in the expenditure side of the budget for 2020 (in the author's assessment of the structure of the budget list) was slightly more than 4.0%. The government of the country and the Ministry of Health of the Russian Federation are also developing tools for the effective functioning of the industry, determine state standards, carry out forecasting and planning, and form a state order program in order to provide the healthcare sector with adequate resources and reserves. However, any of the most perfect goal-setting needs mechanisms for achieving goals, in which scientifically based schemes for making appropriate management decisions play an important role.

In special areas of economic analysis and applied mathematics, problems, technology and techniques for adapting decision-making theory, which developed rapidly abroad in 1950–1960, to a variety of practical problems that have a certain national economic and targeted socio-economic significance, were studied. After an initial rapid influx of theoretical work in the field of corporate time planning, by the end of the 1980s there was a certain lull. Only in the productive 90s, interest in this topic has renewed in connection with the emergence of new cybernetic algorithms and with the dramatically increased processing power and increased volumes of relevant information. This, in turn, led to the emergence of real opportunities to create original science-intensive and practical applications with a truly innovative character [1, 6].

Review of literary sources

Since the 60s of the last century, the theory of managerial decision-making has been widely adopted by modern mathematical and statistical methods. Therefore, in 1965, the American scientist L.A. Zadeh (*Lotfi Alasker Zadeh*) published his work [20], which laid the foundation for the theory of fuzzy (uncertain) sets and developed an independent version of the terminological apparatus on fuzzy (continual) logic. The emergence of algorithms and operations based on fuzzy sets found their application in machine electronic systems of logical inference of expert systems by the end of the 70s and the beginning of the 80s. And later, when predicting the election results, when assessing atmospheric pollution and the state of the environment, when constructing histograms of the ratios of the factors taken into account in the triad of consumer effective demand, price / quality / time, such algorithms and operations proved their suitability for making managerial decisions [5].

In the 80–90s, mass microchips based on the principles of fuzzy logic began to appear on the market, which are especially suitable and useful in creating all kinds of robots, and then in the development of long-awaited artificial intelligence systems. The zero years of the 21st century have been directly related to the creation of more or less plausible scenarios for the development of diverse economic schemes. Moreover, the mechanisms of such scenarios were also based on the ideology of fuzzy logic and fuzzy sets, while the scenarios were primarily developed for large corporate-type businesses, military-industrial complexes and military affairs itself.

At the same time, in the 70s, varieties of the method of expert estimates were created. It was at that time, thanks to E.A. Feibenbaum (*Feibenbaum Edward Albert*, 1971), a professor of Stanford University, an interpreter for mass spectrograms appeared under the working name DENDRAL, which served as a prototype for all expert systems. Already in 1976, the MYCYN expert product (a subsidiary version of DENDRAL) was registered for the practical diagnosis of blood for bacterial and viral infections, which was a full-fledged expert system with unique analytical capabilities of the pattern recognition procedure in the screening and testing mode [16]. In the 1980s and especially in the 1990s, as well as the zero years of the 21st century, later innovative expert systems and advanced methodology of expert assessments have found their widest application in sectors of the economy. They were, above all, for the prompt adoption of scientifically grounded management decisions.

At the end of the 20th and the beginning of the 21st century, similar and related studies were continued, in particular, in the works of essentially his own views, of neo-globalist F. Fukuyama (*Francis Fukuyama*) [9]. The results achieved in this narrower area were used to simplify procedures for solving real applied problems by taking relatively rational and conditionally ranked measures in those areas of social life that are traditionally considered vital, truly problematic and complex. Such areas then and now include state and municipal government, including local government, military and foreign policy, medical diagnostics and health systems [6].

The rates, which usually correspond to the level of the identified *threat metrics* and the state of the organism of sick national economies, are extremely high when making wrong[1] or erroneous[2] managerial decisions here, as nowhere else. The nature of such a peculiar socio-economic threat measurement is determined not only by industry and commercial risks, but also by country, political, demographic and other types of risks. This circumstance (quite pluralistic views on the nature of risk and threat) forces us to apply a systemic and integrated approach to probabilistic assessment of risks and threats to the implementation of socio-economic programs and projects of different levels [17].

The systemic and integrated approaches are traditionally provided using both frequently used measurement methods, for example, expert assessments, categories of elasticity and sensitivity (measured sensibility), decision trees, randomized Monte Carlo algorithms (simulation modeling) for optimization problems, and purely theoretical novelties of the type: scenario analysis algorithm, hidden Markov models[3], R.E. Kalman, neural networks and dynamic Bayesian networks for temporal models. The latter are based on the fruitful and in no way outdated ideas of network processes by the British mathematician T. Bayes [11].

This is a rather conventional novelty of the productive 60s of the 20th century in the form of scenario algorithms, gradually formed from the individual achievements of mathematical statisticians and was based initially on the technology of predicting political and social processes of Ch. G. Kahn (Charles H. Kahn) [16] and in the study [15]. The theoretical innovation turned into a conceptual essence when assessing strategic management decisions in the works of Hawken P., Ogilvy J., Schwartz P. [14] in the 80s. Then it was further elaborated in the 90s, when developing alternative options for the formation scenarios for the future development of commercial structures and large joint projects of business and government in the work of P. Schoemaker [18], as well as in the works of famous Russian scientists [23, 24, 25].

As a result, in less than 20 years of the 21st century, scenario analysis has developed as an independent and rather fastidious approach to making management decisions on a probabilistic basis. It is the probabilities that order the stochastic depths of the unknown that have recently provided themselves, in the opinion of the authors of the article, a certain way of total accounting for the countable measure of uncertainty / uncertainty or the degree of entropy / disorder of systems that arise either for reasons of forced savings of various kinds of efforts, or the actual absence of special knowledge (sometimes both at the same time). The attempts of some economists to apply the conceptual apparatus of the concept of entropy to political processes and to formulate a certain concept of political entropy, the authors of this article consider as having no prospects[4].

Purpose and formulation of the problems of the study

As the experience of domestic administration shows, skillful public administration of such a difficult object as the national health care system even in the difficult post-crisis conditions of the Russian economy, building sound strategies for the development of the industry under study with appropriate combined

[1] The authors see here a type I error with falling into the situation of rejection of a true null hypothesis H_0. The countable probabilities of getting a type I error are calculated using Bayes' Theorem. Figure 3 explains the place of the type I error.

[2] In this case, we understand a type II error, when the initially incorrect / incorrect statistical zero-hypothesis H_1 is mistakenly confirmed / accepted – an alternative hypothesis. For more detail, see [24].

[3] For example, the well-known so-called hidden Markov model, which is a temporal probabilistic model, where the state of the process is described using a single discrete random variable, and possible values of this variable can be possible states of the environment, territory, etc. algorithms.

[4] Yavlinsky G.A. "Apple" wars // "Novaya Gazeta" No. 14 dated 02/10/2021. S. 10–11.

financing allowed a separate subject of the federation, which occupied the 83rd place in the Russian Federation, to sharply rush up to the 3rd place[5]. Here we specifically talked about the successful reform of healthcare in the Kirov region. On 10/22/2020, the Governor of the Perm Territory (PC) D.N. Makhonin in his speech at a meeting of the local legislature announced an equally decisive and rather ambitious approach[6].

The current governor of the PC outlined his strategy as follows: "The primary task is to modernize healthcare. One of the main priorities is personnel. Today, based on the experience of combating coronavirus, we can say that the main difficulty in providing medical care is a certain staff shortage. Compared to the average Russian medical supply, the PC looks not bad, but there are enough problems. Therefore, we include an increase in funding for the "Zemsky Doctor" program (twice) in the budget; we will continue to implement the "Zemsky Feldsher" program. We will strengthen cooperation with the Perm Medical Academy so that as many graduates as possible stay to work in our medical institutions. We will create better working conditions and modernize infrastructure."[7]

The governor outlined a number of priority tasks for the analyzed industry to the regional authorities, namely, increasing the availability of medical care, regardless of place of residence, using the so-called "mobile clinics", digitalization of units, settlement of the personnel problem of medical personnel, repair and construction of medical facilities, renewal of medical equipment and an ambulance fleet, the creation of medical aviation, the fight against oncology and cardiovascular diseases. Already in 2020, as part of the development of the sanitary aviation system, a helipad appeared in a small town Chernushka.

To solve these tasks for the development of health care for the period of 2021–2023, 180 billion rubles are allocated (see Table 1), and in terms of the development of its own medical infrastructure, the PC, as foreseen, will reach a kind of interregional records. Thus, by the end of the three-year period, it is planned to commission 24 new medical facilities in different territories of the region, for which about 8 billion rubles of budgetary funds are allocated. In particular, already in 2021, it is planned to build new medical buildings in Cherdyn and Yurla, four polyclinics in the capital of the region, including those three for children that were not put into operation according to the 2019 Program[8]. Buildings are being renovated in the region feldsher-obstetric points (FOP) and rural medical outpatient clinics (RMOC) are being equipped, new and state-of-art medical equipment is being purchased. For example, in 2020, the PC authorities procured about 3.5 thousand units high-precision equipment, including MRI, CT and ultrasound machines.

The head of the region considers the digitalization of the industry an important point in the strategy for the development of medicine (so far, however, not reflected in the program itself), which will make almost all buildings of polyclinics and hospitals available on the Internet. During 2021, it is planned to connect most of the FOPs to the network, which will open up the potential of telemedicine and, accordingly, will affect the quality of services for those in need, regardless of where they live. Currently, the overwhelming number of residents of the region have an electronic medical record, and all healthcare institutions are already connected to the Unified Information System (UIS), which gives bright hopes for the implementation of the governor's ideas on digitalization of the industry in the PC.

Commenting on the content of the speech of the governor of the PC, one can understand that a specific regional health care system requires a fundamental update based on radical modernization, and not a multi-step optimization of the desired system in the mode of a long-term and painful procedure, but sluggish reform. The governor presents modernization in the form of consistency and compliance of the provision of medical care to the population with modern conditions for the development of medical science, the achievements of practical health care and the requirements of advanced bases of socio-economic standards, including the level and quality of life of Russians [6].

[5] Gaidar M.E. Debriefing / URL: https://echo.msk.ru/sounds/stream.html. (date of access: 12/14/2020).

[6] Speech by the Governor of the Perm Territory // Transformations in the PC health care system. URL: https://www. permkrai.ru/news/dmitriy-makhonin-zayavil-o-preobrazovaniyakh-v-sisteme-zdravookhraneniya-permskogo-kraya. (date of access: 11.12.2020).

[7] Transformations in the PC healthcare system. URL: https://www.permkrai.ru/news/dmitriy-makhonin-zayavil-o-preobrazovaniyakh-v-sisteme-zdravookhraneniya-permskogo-kraya. (date of access: 11/12/2020).

[8] Decree of the Government of the PC of June 17, 2019 No. 411-p "On approval of the Program" Development of children's healthcare in PC, including the creation of a modern infrastructure for helping children." (date of access: 12.12.2020).

Table 1. The main parameters of the budget of the Perm Territory in 2020 and the plane for 2021–2023

No. p/p	Name indicator	2020	2021	2022	2023
1	2	3	4	5	6
1	SME turnover at comparable prices[9], RUB bln	837.0*	869.0**	902.0**	936.0**
2	Fixed capital investments, RUB bln – to the same period, %	229.0 97.0	252.0 97.0	275.0 105.0	294.0 98.0
3	Export, $ billion	3.0*	5.0***	5.8***	5.4***
4	PC budget revenues, RUB bln Chain growth rate, %	141.8* –0.32	145.6** +2.61	156.6** +7.55	165.5** +5.68
5	Budget expenditures, RUB bln Chain growth rate, %	111.7* +0.21	127.4** +14.06	136.5** +7.14	144.8** +6.08
6	Development budget expenditures, RUB bln – in% of line 5	31.4* 28.07	35.7*** 28.02	38.9*** 28.50	41.3*** 28.52
7	Regional budget deficit, RUB bln – in % of income (of the amount of line 4) – in % of expenses (of the amount of line 5)	17.9* 12.61 16.03	18.2* 12.50 14.29	20.1* 12.84 14.73	20.8* 12.57 14.36
8	Budget expenditures on healthcare in PC, RUB bln Chain growth rate, %	55.0** +3.93	57.5** +4.55	60.0** +4.35	62.5** +4.17

Note: * estimate; ** plan; *** forecast.

Source of information: Sat. Macroeconomic statistics of the PC.

Such modernization congruence includes training of medical personnel, optimization of networks of medical institutions, real availability of medical care for any resident of the region, clear programmatic steps in the development and subsequent implementation of the Strategy for the development of the PC health care system. Certain information on filling resources for the implementation of the three-year plan is presented in Table 1.

According to analysts, PC budget losses in 2020 will amount to about 29 billion rubles, with projected federal budget subsidies of 7.7 billion rubles. At the same time, the budget deficit in 2020 is 38 billion rubles, almost 97% of it will be covered by bank loans (by 37 billion rubles with the regional government debt of 4.06 billion rubles).

And if a full-fledged strategy, program and plan for the development of the PC health care system under the leadership of the last governor has yet to be developed (in contrast, say, from the "Strategy for the development of small and medium-sized businesses until 2030", which was developed by the regional Agency for the Development of Small and medium-sized businesses (SMEs) and which was presented on December 11, 2020 at a meeting of the government of the Kama region[10]), then more detailed judgments should be made about the technologies of professional strategizing [25] in the healthcare sector in this article. In particular, deal with the representation of classical planning problems, i.e. with methods of algorithmization of object states, actions and goals of the control system, as well as clarify the problems of scenario modeling, which serves as an advanced toolkit of strategy technology, strategic management methodology and methods of prospective analysis.

Taking into account the above, the authors of this article consider the main provisions and principles of the scenario approach using the example of the development of the PC healthcare system, which makes the material proposed for consideration quite *relevant*. The authors see the main result of improving the industry in assessing the target and national goal – the expected (upcoming) life expectancy of the popu-

[9] In the implementation of plans for the development of the regional healthcare system business entities play an active role in the PPP (public-private partnership) regime.

[10] URL: https: //xn-90aifddrld7a.xn--p1ai/novosti/news/permskiy-kray-stal-pervym-regionom-razrabotavshim-strategiyu-razvitiya-malogo-i-srednego-biznesana. (date of access: 20.12.2020).

lation of the study area. This socio-economic indicator, which has all the signs of fatefulness, is considered by the authors to be a priority analytical indicator of the level and quality of an effective life of a Russian. The latter determines *the purpose* of this study.

The authors consider the construction of dynamic multifactor models of industry development options for a period of up to three years to be an efficient tool for analyzing and forecasting this indicator, which in the article defines a number of special *tasks*: the implementation of the stages of the scenario approach and the construction of a predictive model in the form of a system of five simultaneous equations of multiple regressions.

Research Methods, Methodology and tools

Chronologically, the application of the scenario approach took shape in the late 1980s as an expected and reasonable alternative to univariate econometric forecasts of the future implementation of large-scale investment projects and the prospective development of transnational corporations. However, in essence, the scenarios read out at that time were prepared as tools for the implementation of a corporate strategy. In such scenarios, the emphasis was placed on precisely those positions that were deemed significant for most line managers of these structures and staff analysts during their current discussions of variable management decisions, taking into account the influence of a properly functioning feedback system, Russified and entered into everyday circulation as feedback.

These kinds of connections are extremely useful and preferable to others, provided that there is a sincere desire to know what really happened in the past and to learn from what was done then. And in order to choose a further path of development, the analyst-planner / planner-scriptwriter needs more or less reliable and complete information about the future – a kind of advanced connection with a given perspective, which is very conventionally demonstrated in Fig. 1.

Any event preference, when expressed in the form of utility, is combined with probabilities in a general theory of rational decisions called the decision theory, as follows: *Decision theory = Probability theory + + Utility theory*. It is appropriate here to recall the wisdom of the greats. Thus, Charles-Maurice de Talleyrand-Périgord used to say: "The art of managing public affairs is to foresee the inevitable and to facilitate its fulfillment."[11]

The fundamental idea of decision theory is that any planner analyst is rational if and only if he chooses an action that allows him to achieve the greatest expected public utility, averaged over all possible outcomes of a given action. This forms the essence of the so-called principle of maximum expected utility (MEU). Univariate forecasts, as a rule, rigidly set a single trajectory for the future development of an organization and / or a sectoral department (ministry, profile committee, etc.). But in practice, they most often turned out to be erroneous, in particular because of the ambivalence of the customers of the forecast. Therefore, with a scenario approach for a specific object of research, it is customary to develop several closely probabilistic outcomes (occurrence of events), but noticeably contrasting options for the future development of the external environment of this object.

The task of the scenario method is to develop a certain common understanding in the team of the analyzed object, which will provide its personnel with coordinated actions in achieving the main strategic goals of the actor of the socio-economic space. The main goal of the strategic conversation scheme is to create and launch in the structures of the studied object the process of conscious penetration of employees into the essence of the strategizing procedure [1]. But a more detailed and constructive idea of the process of scenario modeling (planning) can be given by the generally accepted scheme of iterations[12], consisting of eight steps-stages as edited by the authors of the article, tied to the subject of PC and shown in Fig. 2.

[11] Source: URL: https: //citaty.su/aforizmy-i-citaty-sharlya-morisa-de-talejrana. (date of access: 31.12.2020).

[12] Попов С.А. Актуальный стратегический менеджмент. Видение – цели – изменения: учебно-практическое пособие / С.А. Попов. – Москва: Издательство Юрайт, 2016. – 447 с. – (Авторский учебник). – ISBN 978-5-9916-8216-9. – Текст : электронный // ЭБС Юрайт [сайт]. – URL: https://urait.ru/bcode/393975 (дата обращения: 16.02.2021).

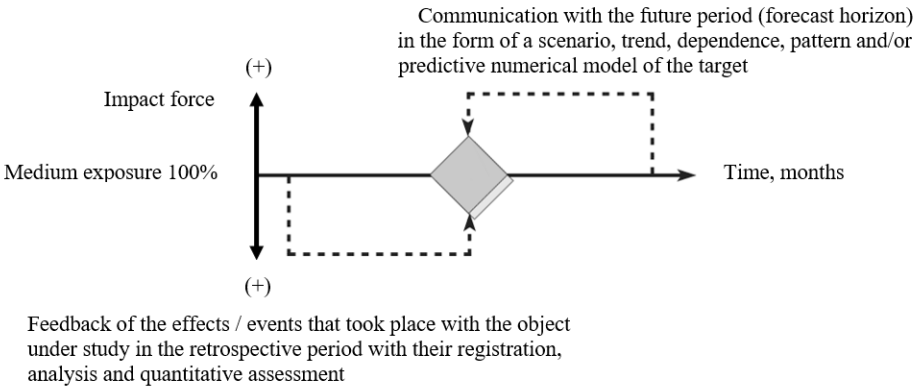

Fig. 1. Conditional scheme of relationships and influences of *feedback*-type effects on the analyst's scenario activity. Compiled by the authors

Nevertheless, it should be remembered that the scenario itself is noticeably different from the model forecast and subjective vision (almost always, desired and individual), but is a convincing description of the most plausible options for shaping the future. The diagram in Fig. 3 allows us to illustrate the differences between the three main categories of perception of future constructions of what is happening. Referring to the generally accepted planning terminology, developers constantly build their sets of actions on the object of study for the planned period, and these actions are most often based on various types of forecasts, scenarios and visions. In stable conditions and in a short time frame, socio-economic forecasts, as a rule, are both necessary and effective, since they allow reducing the considered risks [10], quantifying the complex of threats, and also increasing the certainty of the main events and effects that will occur in the coming periods with the analyzed industry – PC healthcare.

Ideally, each strategic decision in the scheme of the development strategy of the studied object as a whole should become sufficiently stable in any scenario created. But it is extremely difficult to come to such solutions of sufficiency, and in some cases, it is simply impossible. A more typical situation is when certain strategic decisions and / or development strategy of the industry as a whole turn out to be good (simplified semantics) under one or several specific scenarios and bad (semantics of the same level) when analyzing other scenarios.

Therefore, considering the developed scenarios, with a quantitative justification of certain decisions contained in them, for example, those outlined in stage 1, it is necessary to weigh the various risks associated with the probability of the occurrence of certain scenario events statistically. In addition, there should be a deliberate search for such precise strategic decisions that will be sufficient and acceptable for the object under study relative to all available scenarios.

One example of possible risks is the situation with the *Covid*-19 pandemic and its extremely grave consequences for the socio-economic situation not only in the regions, but also in the country as a whole. According to the Rospotrebnadzor for 12.12.2020, the total number of infected in PC reached 12 133. The indicator of the daily increase in patients reached 1.2%, which makes it possible to track the dynamics of the spread of infection in the region. The prevalence rate of the disease as of the indicated date was 1.19 (for comparison, 1.13 as of October 21, 2020)[13].

The large-scale socio-economic consequences of the pandemic have yet to be described by specialists, but it is already obvious today that the population has undergone a targeted strike. According to official data, excess mortality in Russia for eleven months of 2020 exceeded the corresponding period of the previous year by 230 thousand people[14]. According to the unconfirmed information of independent statistician

[13] Map of the spread of coronavirus in PC // URL: / www.permkrai.ru/antivirus. (date of access: 20.12.2020).
[14] Dissenting opinion of prof. Zubarevich N.V. URL: / https: //echo.msk.ru/sounds/2772800.html (date of access: 14.01.2021).

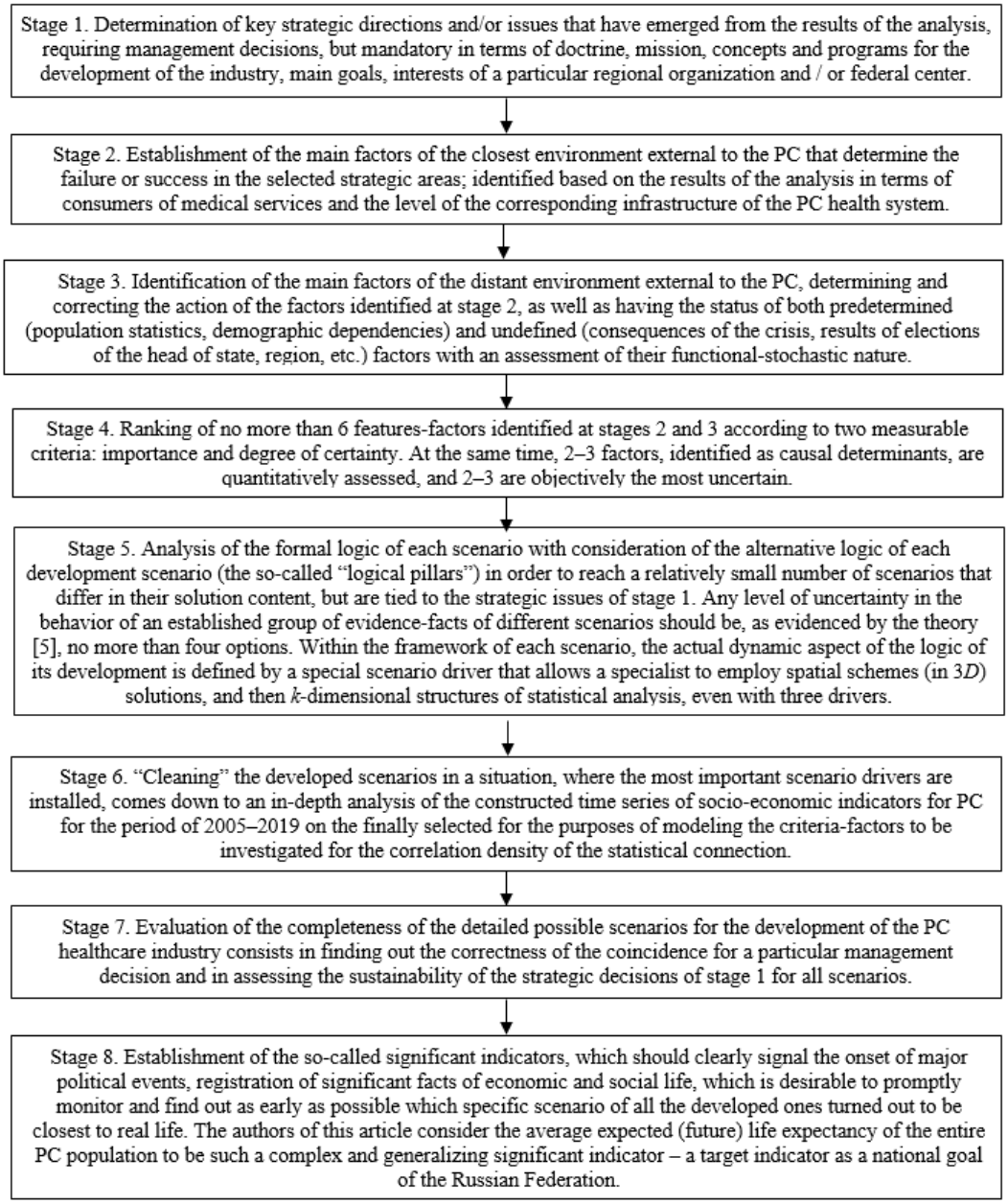

Fig. 2. Stages of the iterative procedure for developing scenarios for the development of the health care system of the Perm Territory for the period of 2020–2023. The standard steps for iterating the stages are given as edited by the authors of the article

A. Raksha (ex-demographer of Rosstat), excess mortality in the Russian Federation is even more significant and reaches as much as 300 thousand people.

More recent and updated information on the registration of deaths and births for April-October indicates a sharp increase in excess mortality compared to 2019 in the Russian Federation – + 16%, and for the so-called highlighted zones: in the first zone of "hard growth" in Moscow – + 26%; Moscow region + 22%; St. Petersburg 26%. In the second zone of "most severe growth": Dagestan – + 46%; Ingushetia + 48%; Chechnya – even + 53%. In November 2020, the statistics are condensed even more – in Moscow + 48.9%; in December, these figures for the capital and St. Petersburg and Leningrad Region are similar

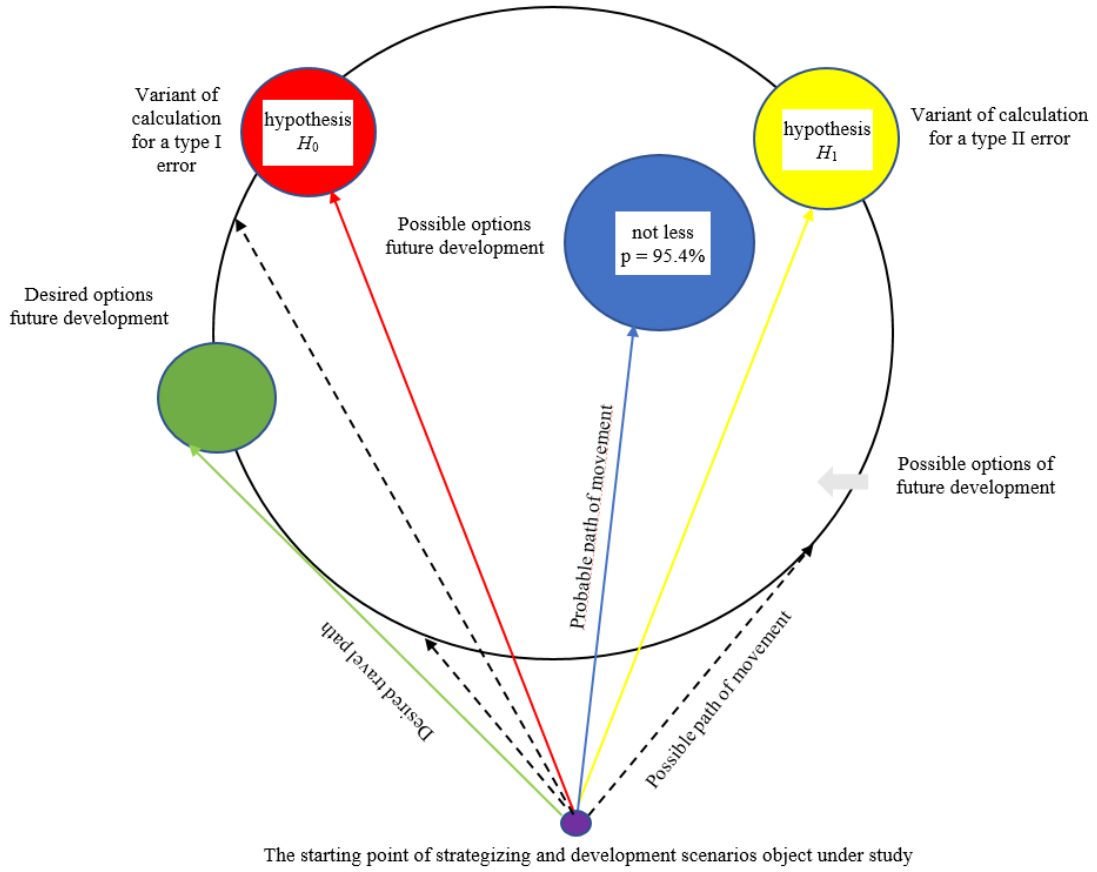

Fig. 3. The relationship between the desired, possible and probable variants of perception of the formed future. The idea of the circuit design was borrowed by the authors from [5]

and are approaching 50 percent. Against this background, the situation in the PC by this indicator turned out to be much calmer[15].

At the same time, the population of the country is significantly decreasing, and at a noticeable pace: from January to September 2020, 1,069 thousand children were born, which is 47 thousand less than in 2019. During the same period, the natural population decline amounted to 387 thousand people against 150 thousand last year. The total population of the country decreased by 510 thousand people against 2020[16]. According to the same demographic statistician A. Rakshi, the decline even reached 590 thousand people[17].

The increase in mortality due to the pandemic will lead to the fact that life expectancy at birth by the end of the past year will certainly decrease. However, the Decree of the President of the Russian Federation of July 21, 2020 No. 474 "On the national development goals of the Russian Federation for the period up to 2030" in paragraph 2a) ("Preservation of the population, health and well-being of people") established a target indicator characterizing the achievement of national goals by 2030 as raising life expectancy to 78 years[18]. If some analysts estimate this indicator for 2019 at 73.3 years in the Russian Federation[19], then the results of 2020 can make their own noticeable adjustments, lowering it by several years at once. To revive

[15] Program "Aces" with prof. N.V. Zubarevich. URL: / https: //echo.msk.ru/sounds/2776966.html (date of access: 21.01.2021).
[16] Remchukov K. Personally yours. https://echo.msk.ru/sounds/stream.html (date accessed: 02/08/2021).
[17] In the circle of light. URL: https: //echo.msk.ru/sounds/stream.html (date of access: 09.02.2021).
[18] Decree of the President of the Russian Federation of July 21, 2020 N 474 "On the national development goals of the Russian Federation for the period up to 2030" // URL: https: //rg.ru/2020/ 07/22 / ukaz-dok.html ... (data obrashcheniya: 10.01.2021).
[19] RBC data // URL: https: //www.rbc.ru/society/16/12/2020/5fbd65c79a794747f677e904. (date of access: 14.01.2021).

the content of the article, it can be noted that at the beginning of 2021 there were more than 5 million people over 80 years old in Russia, and the country's internal affairs bodies even received instructional departmental proposals to store fingerprints for up to 100 years.

The hypothesis put forward by some experts that the main victims of the coronavirus are the elderly from different risk groups has not yet received its final confirmation from sanitary doctors and doctors. But the demographic fact is indisputable – the Russian population is aging. The theses that the age structure of the population does not depend on its size, and that it does not change over time, are considered preliminary by the authors of the article. The nonlinear trend of age-related mortality, i.e. the characteristics of mortality in each age group, differ markedly, depending on the territory of observation, the trend has not been identified in terms of the set of taken into account signs-factors and has not yet been found in open public models.

Thus, the listed theses can also be called working statistical hypotheses. Here, the calculation carried out by the United Nations Program for the Assessment of the Human Development Index (HDI) for Russia, using the structural average, *the median*, may seem useful. Thus, the median age in the country in 2010 was 38.0 years, and by 2020 it had grown to 39.6 years. This means that exactly half of the Russian population in the past year was younger than that age, and the other half was older. Another interesting research, in the context of the discussion, is the per-country estimate of excess mortality using their own original statistical model, which was built by *The Economist* analysts in the context of eliminating the impact of the *Covid*-19 pandemic on the natural population decline in the first row countries [18].

The implementation of the national project "Demography" alone after all adjustments would require the funding of 4.6 trillion rubles from 2019 to 2024. And 90% of the funds, something about 700 billion rubles, according to the Ministry of Finance of the Russian Federation, have already been spent on demography by the end of 2020[20]. Large-scale healthcare costs are always necessary, always appropriate, and almost always inevitable. But the assessment of the effectiveness of such investments can be measured using any complex, composite indicator or associated indicator that characterizes the productivity of investments in the industry under study quite reliably. The authors of the article, fully agreeing with the well-known thesis that "money does not heal", consider the average life expectancy of the entire population of the country (without division by gender) as such a universal indicator, as well as the subject of the federation, including a typical resident of the PC.

In the context of proper digitalization of processes, including demographic processes, improvement of statistical observation, accounting, analysis of fertility, mortality, migration and mechanical movement of the population, such an indicator turns into an indicator of early detection of the concomitant effects of targeted funding and administrative efforts on the ground in specific scenarios and in the field of the strategic competence of the relevant specific organization (say, the Administration and the Government of the PC). Such mastered professional competence in the field of strategizing, in turn, will become quite a solid basis for creating a powerful lever of power structures in the PC for making the necessary decisions, and, consequently, achieving a strategic competitive advantage at the interregional level of the Russian Federation.

The same professional competence will make it possible to carry out a systematic and complex analysis of the developed scenarios in an information environment with serious uncertainty in a qualified manner, taking into account the real-life effects of *emergence* and *synergy* inherent in the scenario. The system under study, for example, a health care management system in the PC alone, may have the property of emergence initially, but given and by default, in a situation when this system is made up of components built on the basis of local elements, which are not inherent in this system property of the system separately.

The property of synergy presupposes a varied interaction of the components of the system, as a result of which the system under study acquires new qualitative varying characteristics depending on the composi-

[20] Правительство вдвое сократило расходы на здравоохранение/ https://www.finanz.ru/novosti/aktsii/pravitelstvo-vdvoe-sokratilo-raskhody-na-zdravookhranenie-1030173928 (дата обращения: 27.02.2021).

tion of the components, which did not initially possess the formed property. These differences in the understanding of the essence of system properties suggest that a type I property is a dynamic derivative from the development of the system under study itself with a fixed set of components. Accordingly, emergence occupies a higher position in the hierarchy of systemic properties than synergy.

A common example is the description of emergent properties in the Bible, the Gospel of Matthew – "Because the Lord said: ... for where two or three are gathered in My name, there I am in the midst of them"[21]. An example of a synergistic property can be the joint action of individual authorities or system elements of the administrative vertical in the forced resolution of a serious problem that has arisen. Or a joint effect on the human body according to a specially prescribed scheme of various drugs, which enhances the healing effect of each of them.

Returning to the problems of financing efforts in healthcare in the PC, it should be noted that the method of raising funds in the region has developed a mixed scheme, which involves both personal funds of the population and state ones, i.e. public finance. The program of state guarantees of free provision of medical care to citizens (SGBP), investment costs, maintenance of medical institutions, including educational institutions, the activities of the sanitary-epidemiological service, etc. are financed at the expense of budget funds.

At the same time, the population of the region pays for medical care both directly, by paying for medical services in state, municipal and private organizations, and through voluntary medical insurance schemes (VHI). The named features of financing can be taken into account in the scenario approach in the course of statistical modeling using traditional and well-known techniques. Modeling difficulties can cause blurred measurements of various kinds of consequences of the gathering strength of the *Covid*-19 pandemic with its many predicted *waves* already throughout 2021.

Results

With the agenda of improving the efficiency of managing a commercial organization and / or administrative (power) structure in the newest conditions, the well-known information and analytical agencies *Deloitte* and *Salesforce* organized an international discussion on the development of scenarios for the development of events with some of the world's best experts in scenario planning to study the impact of the current situation on politics, society and business [3]. As a result of a professional discussion, specialists proposed for consideration four detailed scenarios for the long term (3–5 years): what will the world look like after the coronavirus and what will organizations and economic entities need to safely continue their normal activities in the new conditions? All scenarios mentioned on the forum were created using modeling capabilities.

Construction of an economic and statistical model for the analysis and forecast of the dynamics of the efficient feature

When using systematic statistical methods for evaluating high-dimensional models, consisting of a system of structural equations, quite reliable prospective calculations of interrelated effective signs-factors can be made, even those suffering to a certain extent with the effect of multicollinearity (interdependence, joint dependence of variables) on the forecast horizon from 3 to 5 years [7]. In general, each such structural equation is a dynamic multivariate model (DMM) with a trend component.

The authors of the article used in their research a modification of the V.V. Shvyrkov – A.N. Tsatsulin[22] for constructing the DMM of the upcoming (expected) average life expectancy of the entire PC population from the features-factors taken into account in the work, formed within the health care system of the studied subject. The mentioned system in general form and in generally accepted standard notation can be written in a matrix form as follows:

[21] Bible. Books of Holy Scripture of the Old and New Testaments with parallel passages and appendices. Ch. 18, verse 20 – Moscow: Eksmo Publishing House, 2018. – 771 p. ISBN: 978-5-04-089852-7

[22] Tsatsulin A.N. Primeneniye statisticheskikh metodov pri modelirovanii i kratkosrochnom prognozirovanii razvitiya otrasli (na materialakh konditerskoy promyshlennosti RSFSR) // Dissertatsiya na soiskaniye uchonoy stepeni kandidata ekonomicheskikh nauk / Leningradskiy finansovo-ekonomicheskiy institut im. N.A. Voznesenskogo. Leningrad, 1974. – 228 s.

$$y_h^{(t_i)} = Y\gamma + X_1\beta + \varepsilon_{ht_i}, \quad (1)$$

where $y_h^{(t_i)}$ are the efficient h-variables that are influenced by interdependence at time t_i;

Y is a matrix of effective features from individual structural equations of the system in the i^{th} year;

X_1 is a matrix that includes a set of exogenous and endogenous variables with the identified corresponding time lag;

β, γ are parameters for dependent and independent variables of multiple regression equations;

ε_{ht_i} is a vector of residual random component for each h-variable.

The system from expression (1) can also be written through the so-called reduced form for endogenous variables $y_h^{(t_i)}$, $h = \overline{1,m}$ with zero lag as a system of linear *simultaneous* equations for predefined variables (exogenous and endogenous with lag) and random components of the form ε_{ht_i}. Here, we assume that none of the constructed equations can be expressed as a linear function of the others, since otherwise, one equation would be redundant and the system of equations would be inconsistent. The given form is as follows:

$$y_h^{(t_i)} = \Theta_h Z_h + \eta_{ht_i}, \quad (2)$$

where Z_h is the [1 × m] matrix of predefined variables;

Θ_h is a matrix of linear regression coefficients with dimension [1 × m];

η_{ht_i} is the random component of the already reduced form, which is a linear function of the magnitude of the statistical "residual" ε_{ht_i}.

Regression y_h for all characteristics Z_h can be obtained using the method of least squares (OLS-estimates; *The Method of the Least Squares* – LS) as coefficients of the reduced form Θ_h. The OLS estimates of each equation in system (1) may not represent true estimates of structural coefficients at all. The meaning of the reduced form of the model in this case is that the individual equations that make up the model system can be interpreted as conditional mathematical expectations (MEM), or operator **E** on endogenous variables, provided $\mathrm{E} = \left(\eta_{ht_i}\right) = 0.$

The advantage of the reduced form for forecasting purposes is that its constituent equations express unidirectional relationships between variables. The predefined variables in this case affect the interdependent variables; the inverse statistical effect in the recursive mode is excluded. When forecasting complex socio-economic processes, both of the listed types of models are used in their classical form – recursive and interdependent equations.

Consider the part of the abbreviated form that corresponds to the jointly dependent variables on the right side of expression (1). Estimating it using OLS, it turns out

$$Y = X\left(X^*X\right)^{-1} X*Y + U, \quad (3)$$

where $\left(X^*X\right)^{-1} X*Y$ is the matrix of coefficients of the reduced form, obtained with the help of OLS estimation, in its it meaning corresponds to Θ_h from Eq. (2);

* is a sign of transposition of matrix X;

U is a matrix of random residuals of the system $U = \left\{\eta_{ht_i}\right\}$.

Let us list the stages of constructing structural equations, each of which is a DMM.

1. Since the most effective methods (from those described in the literature) for assessing the statistical relationship have been developed in relation to linear dependencies, and the real dynamics of the socio-economic process is usually described more successfully by nonlinear functions of a multiplicative and power-law form, the initial information for all variables is dependent and independent (pre-selected and analyzed from the point of view of the closeness of the statistical relationship), is subjected to logarithm to the base of the natural logarithm, followed by the calculation of the first differences of the index

series. This operation further enhances the random nature of the distribution of chain indices. That is, the calculation is carried out

$$\ln\left\{Y_{jk}^{(i)}\right\}-\ln\left\{Y_{jk}^{(i-1)}\right\}=\left\{y_{jk}^{(i)}\right\};\quad \ln\left\{X_{jk}^{(i)}\right\}-\ln\left\{X_{jk}^{(i-1)}\right\}=\left\{x_{jk}^{(i)}\right\}. \tag{4}$$

2. At the second stage, to take into account the aggregated features-factors in dynamics and exclude autoregression from the corresponding values of chain indices $\left\{y_{jk}^{(i)}\right\}, \left\{x_{jk}^{(i)}\right\}$, obtained by the formulas from Eq. (4), time trends are excluded. At the same time, analytical alignment is carried out over two homogeneous periods from the point of view of the characteristics of the development of regional health care (different configuration of time trends), in the specific case of the dynamics of meso-indicators of PC: those are 2005–2008 and 2009–2019. With a more preferable length of the time series system (say, from 1991 to 2020) and under specific conditions of periodization of dynamics, the number of sub-periods identified can be greater. The aggregates of residual deviations from their time trends in the form of linear functions are marked from above with the mathematical sign "wave" (~, i.e. the upper tilde):

$$\left\{y_{jk}^{(i)}\right\}-\left\{y_{jk}\left(t_i\right)\right\}=\left\{\tilde{y}_{jk}^{(i)}\right\};\quad \left\{x_{jk}^{(i)}\right\}-\left\{x_{jk}\left(t_i\right)\right\}=\left\{\tilde{x}_{jk}^{(i)}\right\}. \tag{5}$$

3. At the third stage, there is the estimation of the degree of linear correlation of residual deviations from time trends in subsets from Eq. (5) and calculation of the so-called net coefficients of elasticity $\{a_{jk}\}$ in the equations of multiple regression of the dependent variable on explanatory variables as a column matrix of regression parameters.

At this stage, various estimation methods are applied and sequentially analyzed-generalized OLS according to Aitken A.C. [10], in which the covariance matrix of the vector of random variables is estimated, and two-step OLS according to H. Theil [8, 15], by which the reduced form is simultaneously estimated. Individual dependencies are preliminarily evaluated as equations belonging to the recursive system.

Although these estimates $\left\{\mathrm{E}\left[LS\left(a_{jk}\right)\right]\right\}$ are not fully *consistent* and *unbiased*, they nevertheless give a general idea of the order of magnitude of the pure coefficients of elasticity, therefore their calculation is very useful as characteristics of the comparative sensitivity of variability of features-factors. At the same time, on their basis, it is possible to obtain the values of the coefficients of determination for each of the structural equations to clarify the *explained* variability of the features-factors taken into account in the modeling.

4. At the fourth stage, each structural equation of the model provides elements of dynamism not only by introducing time trends into the model, but also by aggregated factors (for example, the official percentage of excess mortality under *Covid*-19, drug pricing, deepening of the economic crisis, inflation expectations [22] transfers from the federal budget, etc.), taken into account at this stage by the authors of the article using a special method.

5. Calculations of the fifth stage provide for the calculation of special statistical indicators and criteria for the reliability of the parameters of the model based on deviations from Eq. (5), and verification of statistical tests and hypotheses: the normalized coefficient of multiple correlation for the entire retrospective period $\left(\overline{R}_m\right)$; coefficient adjusted for the random sample size $\left(\hat{R}_m\right)$; R. Fisher's corrected theoretical ratio $\left(\hat{F}_{meop}\right)$; empirical Durbin-Watson test (DWэ). These estimates involve intermediate calculations for the 3rd and the 4th stages of modeling.

6. At the sixth stage, the forecast values of the variables are verified (a set of indicators for the development of the health care system and population statistics) given by the model based on the actual data of years of the quasi-retrospective period, i.e. for the years that have already been reported. Such a check reveals (or not) the appropriate predictive capabilities of the model for each of the scenarios considered in this study. Thus, the proposed model for analyzing and forecasting the expected (upcoming) average life

expectancy of the entire PC population can successfully serve as a tool for prescheduled calculations for 2021–2023 and development of a strategy for the development of the health care system of the studied federal subject for a more significant perspective.

7. At the seventh and last stage, when various values of predetermined (mainly exogenous) variables are introduced into the corresponding structural equation, they can be "played" by the capabilities of information technologies on good-quality application packages of the latest generations such as *SPSS*-16 and *Statistica*-11 forecast options for the constructed model in the general structural shell. Further, the optimal scenario of development from the point of view of the successful functioning of the studied healthcare system is selected. When setting the variant values of variables for the forecast horizon, it is advisable to involve expert assessments of relevant specialists as an auxiliary material in measuring the ranks and ratings of risks [17] and threats.

Carrying out calculations at the last stage, it should be borne in mind that the assignment of alternative options for values for a number of variables associated with the creative planning-variative activity of PC controls allows you to quantitatively measure the comparative effectiveness of individual levers of programs, concepts and strategies of the socio-economic development of the territory and their cumulative impact on the life expectancy of an average Permian. It is not only the main socio-economic indicator of the development of the territory, but also the target indicator, as well as the national goal.

Let us list the endogenous and exogenous variables, used in this modeling content, with their conventions:

$y_{1,1}^{(i)}$ – Budget revenues of a constituent entity of the federation (PC) in current prices in the i^{th} year;

$x_{1,1}^{(i)}$ – Gross regional product (GRP) of the region in current prices in the i^{th} year;

$x_{1,2}^{(i)}$ – Tax revenues to the regional budget at current prices in the i^{th} year;

$x_{1,3}^{(i)}$ – SME turnover in comparable prices in the i^{th} year;

$y_{2,1}^{(i)}$ – Expenditures of the regional budget for the development of the health care system in comparable prices in the i^{th} year;

$x_{2,1}^{(i)}$ – The volume of funds of the regional VHI system in comparable prices in the i^{th} year;

$x_{2,2}^{(i)}$ – The size of the PC budget deficit in comparable prices in the i^{th} year;

$x_{2,3}^{(i)}$ – The average annual population of the PC in the i^{th} year according to the official statistical reporting until 2019[23];

$y_{3,1}^{(i)}$ – Expenditures for the development of the PC healthcare infrastructure in comparable prices in the i^{th} year;

$x_{3,1}^{(i-1)}$ – Interbudgetary targeted transfers in comparable prices in the previous i^{th} year;

$y_{4,1}^{(i)}$ – Contributions to the OMS PC fund in comparable prices in the i^{th} year;

$x_{4,1}^{(i)}$ – The level of general morbidity in the region in the i^{th} year;

$x_{4,2}^{(i)}$ – The volume of paid medical services for the PC in comparable prices in the i^{th} year;

$x_{4,3}^{(i)}$ – Comparative index of retail prices for medicines and medicines from the List of vital and essential medicines for medical use[24] in the retail and hospital network of the PC in the i^{th} year;

$y_{5,1}^{(i)}$ – The upcoming (expected) average life expectancy of the region's population in the i^{th} year;

[23] The indicator of the average annual number in the PC is taken into account, since all the characteristics of natural population decline are assessed precisely against this initial base.

[24] Decree of the Government of the Russian Federation of August 12, 2020 No. 1212 "On Amendments to the Rules for the Formation of Lists of Medicines for Medical Use and the Minimum Range of Medicines Required for the Provision of Medical Care". URL: https://www.garant.ru/products/ipo/prime/doc/74411004/ (date accessed: 01/10/2021).

$x_{5,1}^{(i)}$ – The birth rate in the region in the i^{th} year;

$x_{5,2}^{(i)}$ – The mortality rate in the region in the i^{th} year;

$x_{5,3}^{(i-1)}$ – Infant mortality rate[25] in the region, that is, throughout the territory of the subject of the federation the Perm Territory, in the previous i^{th} year[26].

Let us give a schematic architecture of the linearized structural equations of a complex of dynamic multifactorial models of the development of the PC health care system in the statistical assessment by systemic methods, namely, DMSS, for the specified retrospective period 2005–2019 with periodization of the dynamics by a system of coupled time series with verification for 2020 and a random component ξ_{h,t_i} for each individual isolated equation from the system.

1. Budget revenues of the studied subject of the Federation (Perm Territory):

$$\begin{array}{ccccccccccc} y_{1,1}^{(i)} & = & a_{1,0} & + & a_{1,1}x_{1,1}^{(i)} & + & a_{1,2}x_{1,2}^{(i)} & + & a_{1,3}x_{1,3}^{(i)} & + & a_{1,t}\left(t_i - \bar{t}_i\right) + \xi_{1t_i}, \\ & & (0.00587) & & (0.711) & & (0.679) & & (0.951) & & (-0.00174) \end{array}$$

$$\overline{R}_m = 0.8815;\ \hat{R}_m = 0.8417;\ \hat{F}_{meop} = 1.41;\ DW_{\text{Э}} = 2.03. \quad (6)$$

2. Expenditures of the regional budget for the development of the health care system:

$$\begin{array}{ccccccccccccc} y_{2,1}^{(i)} & = & a_{2,0} & + & a_{2,1}y_{1,1}^{(i)} & + & a_{2,2}x_{2,1}^{(i)} & + & a_{2,3}x_{2,2}^{(i)} & + & a_{2,4}x_{2,3}^{(i)} & + & a_{2,t}\left(t_i - \bar{t}_i\right) + \xi_{2t_i}, \\ & & (0.00302) & & (1.297) & & (-1.124) & & (-1.876) & & (0.0217) & & (-0.00544) \end{array}$$

$$\overline{R}_m = 0.9475;\ \hat{R}_m = 0.9308;\ \hat{F}_{meop} = 1.15;\ DW_{\text{Э}} = 2.09. \quad (7)$$

3. Expenditures for the development of the regional healthcare infrastructure:

$$\begin{array}{ccccccccccccc} y_{3,1}^{(i)} & = & a_{3,0} & + & a_{3,1}x_{1,1}^{(i)} & + & a_{3,2}x_{3,1}^{(i-1)} & + & a_{3,3}y_{1,1}^{(i)} & + & a_{3,4}y_{2,1}^{(i)} + & a_{3,t}\left(t_i - \bar{t}_i\right) & + \xi_{3t_i}, \\ & & (0.00176) & & (0.732) & & (0.301) & & (1.126) & & (0.434) & (0.00598) & \end{array}$$

$$\overline{R}_m = 0.9593;\ \hat{R}_m = 0.9418;\ \hat{F}_{meop} = 1.13;\ DW_{\text{Э}} = 1.94. \quad (8)$$

4. Contributions to the regional compulsory medical insurance fund:

$$\begin{array}{ccccccccccccc} y_{4,1}^{(i)} & = & a_{4,0} & + & a_{4,1}y_{3,1}^{(i-1)} & + & a_{4,2}x_{4,1}^{(i)} & + & a_{4,3}x_{4,2}^{(i)} & + & a_{4,4}x_{4,2}^{(i-1)} & + & a_{4,5}x_{4,3}^{(i)} & + \\ & & (0.00319) & & (0.776) & & (0.802) & & (0.486) & & (0.612) & & (0.877) & \end{array}$$

[25] In the Volga Federal District, the PC in terms of infant mortality, i.e. the number of children who died before the age of 1 year per 1,000 live births was 4.7 ‰ in 2018, and 5.2 ‰ a year earlier. In 2019, the indicator dropped to 4.6 ‰, but it is significant that 65.90% of the total number of babies who died before the age of one year were children of the first month of life [26]. In the countryside, this indicator is much higher. In recent years, the methodology for calculating the infant mortality rate $K_{\text{inf.}mort}$ has undergone certain changes. Now this coefficient is measured as the sum of two components: the first is the ratio of the number of deaths up to a year in the current year $\left(m_1^{(1)}\right)$ from the generation of those born in the current year to the total number of those born in the considered year (N_1); the second is the ratio of the number deaths under one year in the current year from the generation of those born in the previous year $\left(m_1^{(0)}\right)$ to the total number of births in the previous year (N_0): $K_{\text{inf.}mort} = \frac{m_1^{(1)}}{N_1} + \frac{m_1^{(0)}}{N_0}$.

[26] The program "Development of children's health care in the Perm region, including the creation of a modern infrastructure for the provision of medical care to children". Approved by the Resolution of the Government of the Perm Territory dated June 17, 2019 No. 411-p. http://docs.cntd.ru/document/561434147 (date accessed: 02/08/2021).

$$+ \underset{(-0.00072)}{a_{4,t}\left(t_i - \bar{t}_i\right)} + \xi_{4t_i},$$

$$\overline{R}_m = 0.9336; \quad \hat{R}_m = 0.8953; \quad \hat{F}_{meop} = 1.26; \quad DW_{\text{Э}} = 1.82. \tag{9}$$

5. The upcoming (expected) average life expectancy at birth for the entire population of the region:

$$y_{5,1}^{(i)} = \underset{(0.00411)}{a_{5,0}} + \underset{(0.523)}{a_{5,1}y_{4,1}^{(i-1)}} + \underset{(0.621)}{a_{5,2}y_{3,1}^{(i-1)}} + \underset{(0.194)}{a_{5,3}y_{2,1}^{(i)}} + \underset{(0.461)}{a_{5,4}x_{5,1}^{(i)}} + \underset{(-0.543)}{a_{5,5}y_{5,1}^{(i-2)}} +$$
$$+ \underset{(-0.628)}{a_{5,6}x_{5,2}^{(i)}} + \underset{(-0.124)}{a_{5,7}x_{5,3}^{(i-1)}} + \underset{(-0.00102)}{a_{5,t}\left(t_i - \bar{t}_i\right)} + \xi_{4t_i},$$

$$\overline{R}_m = 0.823; \ \hat{R}_m = 0.789; \ \hat{F}_{meop} = 1.03; \ DW_{\text{Э}} = 1.28. \tag{10}$$

Discussion

Depending on the chosen development scenario, a three-year plan for improving the infrastructure of the region, providing for the development of more than 8 billion RUB budget funds and the commissioning of 24 healthcare facilities by the end of 2023 may be subject to significant adjustments. So, the optimistic version of the development of the system will allow the restoration of the previous specialized emergency teams, including cardiology, to those that remained in conditions of limited funds and a pandemic – linear, intensive care, children, etc. psycho-brigades. The medical personnel of the ambulance service from the units, operating at the end of 2020 are simply not able to provide assistance in serious cases: clinical deaths, pulmonary edema, road accidents, heart attacks. The number of calls per day dropped[27]. Adjustment of scenarios may even affect facilities built in the PPP regime over the years.

2021: Surgical building of the hospital, Tverie; Hospital for Infectious Disease; New building of the regional oncologic dispensary; Medical building in Cherdyn; Medical building with a polyclinic in S. Yurla; Children's polyclinic in Kudymkar; City Clinical Polyclinic in Perm; 3 children's polyclinics in Perm.

2022: Children's polyclinic in Perm (Motovilikhinsky district); Regional hospital complex in Polazna settlement; Children's polyclinic in Tchaikovsky; Polyclinic in S. Siwa;

2023: Hospital of the regional psychiatric hospital in Perm; Surgical complex in Kudymkar; Psychoneurological dispensary in Perm; Polyclinic phthisiopulmonary building in Perm; Medical diversified building in Perm.

With the total amount of funds allocated for three years under the optimistic scenario of the development of the healthcare system in the amount of 180 billion RUB, the number of doctors per 10 thousand of the population of the region will be 37.8, which by the end of 2023 will exceed the level of provision in the Volga Federal District (with the respective number of 36.1) and even in the Russian Federation (at the level of 37.6). At the same time, the Program envisaged to increase payments to zemstvo doctors and zemstvo paramedic by about 2 times in comparison with 2020 (up to 2 million RUB and 1 million RUB, respectively) in the framework of the same optimistic scenario for the development of the PC health care. The universal indicator of the improvement of the health care system (target indicator) chosen by the authors of the article in their study made it possible to simulate predictive calculations in Eq. (10) for three selected scenarios for the period of 2021–2023, which is reflected in Table 2. For comparison, in the northern capital, it is envisaged to finance the city health system and the pharmaceutical industry in the amount of 122 billion RUB only for 2021, which exceeds 16.0% of all expenses, however, there is a deficit budget of the federal subject.

[27] URL: https://59.ru/text/health/2020/12/30/69672816/. (date of access: 18.01.2021).

Table 2. Dynamics of the expected (future) life expectancy at birth of the entire population of the Perm Territory when modeling a scenario forecast for the period 2020–2023

No. p/p	Name indicator	Forecast scenario		
		pessimistic*	optimal (successful)**	optimistic***
1	2	3	4	5
1	Life expectancy at birth, years 2020 (Born 1947) year	73.2	73.9	74.4
2	2021 (Born 1948) year	73.2	73.9	74.5
3	2022 (Born 1949) year	73.1	74.0	74.5
4	2023 (Born 1950) year	73.2	74.1	74.6
5	*p*-values at 5% significance level	0.000347	0.000211	0.000076
6	The coefficient of determination according to the model from Eq. (10) $d^2_{y_{5,1}}$, %	67.73	68.91	68.35
7	Standard error, %	0.307043	0.312874	0.313950
8	The autocorrelation coefficient of the residual values r_a	–0.24754	–0.23965	–0.24113
9	Empirical Durbin-Watson coefficient DW_{emp}	2.7133	2.45321	2.54498

Note:
– the number of observations n = 16, taking into account the year used for verification;
– scenarios in relation to this indicator can be conventionally named as options: * "Kazakh"; ** "Belarusian"; *** "Latvian".

Conclusions

According to the authors of the article, scenario modeling gives a chance to increase the sustainability and improve the flexibility of business design for almost any business structure and management system. But even an economic-statistical model of a sufficiently large dimension, however, which does not possess the declared flexibility to the external and internal habitat of the object under study, will be characterized by excessive resource intensity, adjusted for crisis circumstances, and increased vulnerability to threats and risks.

Optimally flexible models of the corresponding variant of the scenario approach, on the contrary, significantly increase the possibilities and effectiveness of strategizing, since they do not exclude delays in making those managerial decisions that are fatal for the PC population. The authors believe that scenario forecasts of the functioning of the mechanism for managing the national health care system and measures to increase the average life expectancy of Russians belong to such managerial decisions of the national level. However, we should admit that the proposed model of life expectancy does not include the factors of influence of the *Covid*-19 pandemic, which will certainly lower the predictive estimate of the target.

During the first part of the research, the authors chose the following:

1. Health care was selected as the most balanced indicator of improvement and effectiveness (in terms of the speed of its manifestation) of the functioning of any system, be it federal or regional. The average expected (future) life expectancy of a Russian was studied as such an indicator.

2. A multistep algorithm for the implementation of the scenario approach was reasonably chosen when developing three options (under the influence of a multitude of taken into account signs-factors) of the development of the research object and making an appropriate managerial decision on a particular financial-economic and / or socio-economic situation / problem (Fig. 2).

3. In the course of the correlation-regression analysis and assessment of the measure of the closeness of the statistical connection, a group of features-factors under consideration, interdependent and forming the level of technical, economic and demographic indicators of the studied region for the period 2005–2019, was selected. The list of the features-factors selected for modeling, including those with the set time lag, is given on pp. 25–26.

4. Five equations of multiple regression were constructed according to the modified method of V. Shvyrkov–A. Tsatsulin, which were combined into a system representing a single dynamic multifactor model of the main indicators of the development of the PC healthcare industry. The numerical parameters of the conditionally independent parameters of this model on p. 26 show how the net elasticity coefficients were estimated using the two-step least squares method (LLS) based on the advanced SPSS-16 software package.

5. Based on the results of statistical multivariate modeling and forecasting in the medium term, estimates of the target indicator and the national goal, the expected (future) life expectancy of the PC population, were established as a balanced indicator in this study. The calculation results are presented in Table 2.

Directions for further research

In continuation of this study, the authors of the article suggest the following.

First, after waiting for the official statistics of meso economic indicators for the PC for 2020, they will first carry out verification comparisons of predictive calculations using the author's model from a system of five simultaneous dynamic equations of multiple regression of linear forms from expressions (6) ÷ (10). If necessary, the net elasticity coefficients will be adjusted for independent variables, and already with the adopted amendments, the forecast of the main characteristics of the PC territory for the another impending three years will be made within the framework of the scenario approach to the development of the regional health care system, taking into account its specifics.

Secondly, the study of the impact and consequences of the *Covid*-19 pandemic on the PC economy is of particular interest to the authors of the article. For 17 months of attention to the coronavirus infection, that ruined Russian open spaces, a rich and interesting statistical material has already been accumulated. The authors intend to skillfully and correctly analyze this database in order to improve the methods and technologies of strategizing when using the scenario approach for making certain management decisions.

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