Creating an Innovative Business Model for the Performance of Commercial Dental Clinics

Evgeniy V. Kostyrin [1*] , Grigoriy G. Bagdasaryan [1]

[1] Bauman Moscow State Technical University, Russian Federation.

Abstract

Providing dental care to the population is associated with the active introduction of new technologies, personnel management methods, and business processes. In this sense, dentistry is at the forefront of the development of medicine and other economic sectors. However, the active practical implementation of advanced technologies for the provision of dental services requires personnel to have increased motivation and highly qualified labor, to develop new protocols for patient management, and to use more advanced equipment and materials, while administrative and management personnel should introduce progressive methods of labor motivation and economic and mathematical models of material and moral stimulation. This research aims to create an innovative business model for the development of a commercial dental clinic (CDC) that provides paid dental services. Economic and mathematical modeling and nonlinear programming are aimed at maximizing dentists' wages, together with financial incentives for the work of administrative and managerial personnel and deductions for the development of a typical commercial dental clinic in Moscow based on the actual volume of dental services and the costs of their provision. With the volume of paid dental services growing by one and a half times, the innovative business model makes it possible to increase clinic income by a factor of 1.66 and dentists' salaries by a factor of 2.24, raise deductions for labor incentives for administrative and managerial personnel by a factor of 1.66, and increase total profit by a factor of 1.75. During the research, it was possible to ensure early repayment of a loan of 5 million rubles for clinic development in 21 months. Additional research is needed because of the possible variability of the dental market and lending conditions.

Keywords: Innovative Business Model; Dentistry; Commercial Dental Industry; Economic And Mathematical Model; Labor Incentives; Wages; Dentist; Dental Services; Management Model; Innovation Model.

1. Introduction

Digitalization in dentistry for many years to come determined the trajectory of economic development for commercial dental organizations (CDOs) and had a significant impact on their daily medical activities [1–3]. First of all, it concerns orthopedic dentistry [4], which recently introduced milling technologies, computer modeling [5], 3D printing [6], and other methods of using modern advances in computer technology, information, and telecommunication systems at a rapid rate. Thus, numerically controlled milling machine tools for the manufacture of artificial teeth, bridges, and crowns are becoming widespread, and such machines can be remotely controlled using mobile phones, tablets, and other devices with Internet access. In addition, hybrid technology is a very promising direction for further research; it combines the advantages of analog techniques (traditional manufacture of artificial teeth) [7] and digital methods while significantly reducing the disadvantages inherent in each of these methods separately, which makes it possible to judge the synergistic effect from the combined use of these techniques [8, 9].

The high clinical efficacy of digital methods requires economists, researchers, and specialists in the field of healthcare organizations to analyze the economic efficiency of the production process digitalization in the trajectory of economic development of a CDC [10, 11], which will provide the managerial decision-maker with scientifically based information about the necessary material costs for the purchase of necessary equipment (3D printers, milling machines, and other dental instruments and equipment) [12], and capital investment in the creation of a CDO and ensuring the necessary trajectory of its economic development. Another significant trend in the research is the factor analysis of CDO costs and the development of effective models for the process management of CDO financial flows using the achievements of modern economic science and mathematical programming methods [13].

For effective CDO activities, it is necessary to create mechanisms for managing the digital production process [14–16] and denture production at all stages, from design in CAD/CAE systems to the dentist's work when seeing a patient. It is required to create protocols and economic incentives to reduce violations associated with human factors, namely, the number of breakdowns of removable and fixed dentures, the number of citizens' appeals due to poor-quality treatment and prosthetics, the share of negative customer reviews on the Internet and social networks (messengers), and other types and factors that can harm the reputation and, ultimately, the CDO market value [17–19]. A preventive element should also be included in the system for assessing the quality of dental treatment, especially in the matter of preventing the development of caries [20–22].

Providing dental care to the population is associated with the active introduction of new technologies, personnel management methods, and business processes. In this sense, dentistry is at the forefront of the development of medicine and other economic sectors. However, for the active practical implementation of advanced technologies in the provision of dental services, personnel should have increased motivation, demonstrate highly qualified labor, develop new protocols for patient management, and introduce more advanced equipment and materials. Top managers should introduce progressive methods of labor motivation and economic and mathematical models for material and moral stimulation.

The creation and improvement of business models for the development of commercial dental clinics, with regard to their special social significance, directly impacts the quality of life and well-being of the country's citizens, and this is one of the most essential tasks of modern social development. Currently, innovative mechanisms and technologies for managing the development of integrated corporate structures in dental businesses and small businesses are reaching a new level due to the need to mobilize the community's forces in priority areas of development and improve its well-being, length, and quality of life [8, 23, 24]. The main contradiction identified during the research is that the existing scientific and methodological support for the processes of managing dental business development does not create the prerequisites for increasing the efficiency of its work, the introduction of advanced technologies for material labor incentives for health workers and administrative and managerial personnel, and advanced technologies for managing the financial flows of an enterprise and the social security of workers [25].

Existing business processes for the development and modernization of commercial dental clinics can be characterized as ineffective since there is no holistic scientific and methodological approach to making informed managerial decisions based on economic and mathematical methods and models integrated into everyday practice. Problems of low efficiency in business processes are associated with fragmentation and imperfection of the economic and mathematical apparatus and instruments used in practice and methods for labor incentives [13, 14, 26]. Attempts to create a full-fledged, comprehensive, innovative system for the development and improvement of business processes in commercial dental clinics, including a progressive system of incentives for workers, deductions to the enterprise development fund, and effective mechanisms for managing financial resources based on the developed methodology of economic and mathematical modeling of processes for managing the development of medical organizations, are presented in [27–29]. However, their main drawback is that the issues of managing investments in the development of organizations have not been fully worked out, criteria for making informed managerial decisions aimed at organizing the interaction of patients with dental medical organizations and commercial dental clinics according to the categories of medical care provided have not been developed, and the issues of medical organizations' development through loans and external sources of financing, including schemes for repaying debts to creditors and investors, have not been studied. However, this is one of the key issues and the most significant obstacle to the development of commercial medical organizations, in particular networks, large, corporate, commercial dental clinics, and those operating as small businesses.

Challenging targets require advanced technologies, progressive approaches, and innovative business models for managing all processes in organizations, namely, financial flows, personnel, investments, innovations, and promising systems for financing their activities. Nonlinear processes and computational methods for managing such systems are becoming increasingly relevant as the most effective instruments for making managerial decisions and providing scientifically substantiated algorithms and models for the development of control objects. When managing complex systems with numerous interrelated parameters, the need arises to use algorithms and nonlinear programming methods to achieve the best result from the many possible values of the dependent variable with limited ranges of changes in the influencing factors. As a rule, the objective function and each of the inequalities in the system of constraints of the

optimization problem in most modern models for controlling real processes are nonlinear functions, which impose additional restrictions on control objects and require special mathematical models and instrumental methods for solving such problems. Thus, in the problems of managing the development of medical organizations, nonlinear and quadratic programming methods have proven themselves well [30].

Thus, economic and mathematical modeling of the innovative development of commercial dental clinics, sound policies regarding existing and promising methods of their financing and investment, debt repayment schemes and interaction between the clinic and investors, an instrumental framework for managing their development, promising and effective technologies for their financing and assessing the effectiveness of investments in their development, structural systemic analysis, internal and external environmental factors, scientifically substantiated personnel policies, and the labor incentive system for health workers and administrative and managerial personnel are important and relevant scientific and practical problems for the national economy.

The current system of organizing and financing dental care in the Russian Federation motivates RF citizens to increase the volume of paid dental services provided to the population in state and commercial dental medical organizations. Thus, according to T. Beskaravainaya, the correspondent of the "Doctor and Society" section of the specialized portal for medical specialists and healthcare organizers "Medvestnik" [31], dental patients choose private clinics because of the absence of queues and the quality of services. It was noted that the absence of queues and the ability to quickly get an appointment, combined with the quality of treatment, were the main reasons why 70% of patients preferred private dentistry to public dentistry. This result, in our opinion, is quite logical if we pay attention to the low availability of dental care provided by the compulsory health insurance (CHI) system for the population of the Russian Federation. In particular, the Program of State Guarantees for the free provision of medical care to citizens for 2023 and for the planning period of 2024 and 2025 [32], in terms of determining the procedure and conditions for the provision of medical care and criteria for the availability and quality of medical care, stipulates that the timing of consultations with medical specialists (except for suspected cancer) should not exceed 14 working days from the date the patient contacts the medical organization. In such a situation, patients prefer to apply for paid dental services to public dental medical organizations or to CDCs to obtain dental care on the day of application, rather than wait for the standard deadlines established by the State Guarantees Program (14 days) to receive dental care in the compulsory medical insurance system.

Kostyrin et al. [33] also note the low accessibility of dental services provided at the expense of the Federal Fund for Compulsory Medical Insurance for the population of the Russian Federation, namely, the share of the tariff for payment of requests for diseases in the "dentistry" profile for the adult population in the average annual expenses of the CHI Federal Fund for medical care per insured person is on average 4.13% in the country, which indicates the extremely low financial security of dental care for the population of the Russian Federation at the expense of CHI funds.

According to the "Analysis of the dental services market in Russia" prepared by BusinesStat in 2023 (see Figure 1), in 2022, the volume of the commercial dentistry market in the country decreased by 8.2%: from 77.7 to 71.3 million appointments. The decrease in demand for paid medical services occurred due to a sharp increase in dentistry prices and a partial outflow of solvent clients from the country.
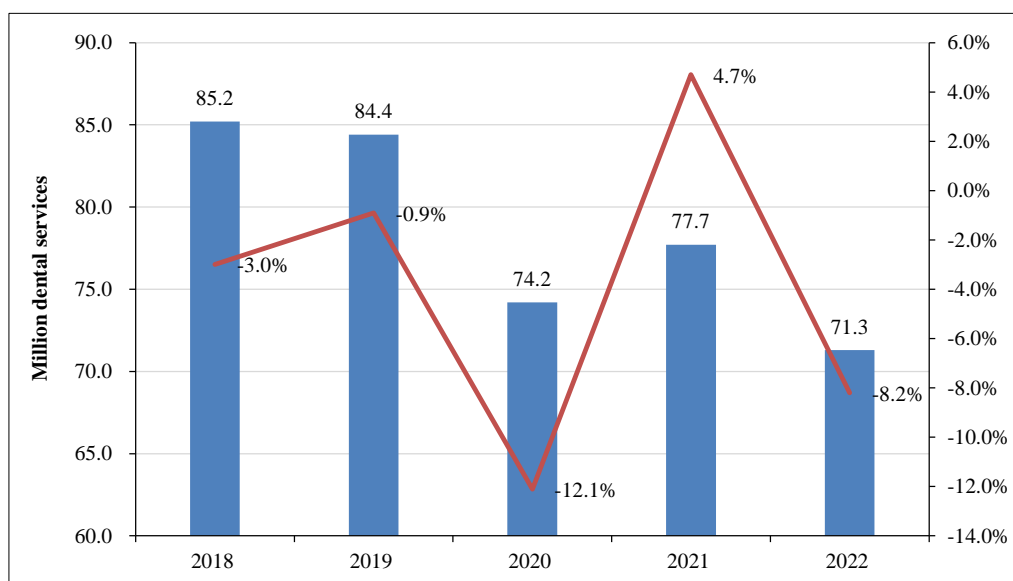

Figure 1. Volume of the commercial dentistry market in Russia from 2018 to 2022

Geopolitical tensions in 2022 led to increased complexity of logistics, instability of exchange rates, difficulties in paying for supplies through a number of Russian banks, and an outflow of business and population abroad. The availability of imported materials and equipment for Russian dental market operators has decreased, and their cost has increased. As a result, the prices for dental appointments have risen to record levels. In the context of rising dental prices in Russia, purchasing activity froze, and patients with low incomes moved to dental clinics in a lower price segment or began to have their teeth treated under compulsory medical insurance policies. At the end of 2022, it was not possible to maintain the pre-crisis volume of the client base of dental clinics. In 2018–2020, the number of paid dental appointments in Russia decreased by 12.9%, from 85.2 to 74.2 million. The main decline occurred in 2020 (-12.1%). Due to strict quarantine to contain the spread of COVID-19, dental care consumption sharply declined (see Figure 1).

In 2021, the volume of the domestic market for paid dental services partially recovered and amounted to 77.7 million appointments. Deferred demand was the key influencing factor following the strict coronavirus restrictions of 2020. At the same time, according to numerous studies [34–36], most dental specialists, health care managers, and epidemiologists agree that at least 99% of the population worldwide, including in Russia, needs regular dental care services.

Despite the high social significance and demand for dental services by the population, existing business processes for CDO management can be characterized as ineffective because there is no holistic scientific and methodological approach integrated into dental practice for making informed management decisions based on economic and mathematical methods and models. There are still problems when dentists are forced to combine work in state dental medical organizations and part-time work in a CDO in their free time from their main job, which results in the low quality of dental services provided, a high percentage of faulty and warranty service, and a high proportion of timely non-identified diseases of the oral cavity, which can be associated with serious consequences. Problems of low efficiency in business processes used in the CDO are associated with fragmentation and imperfection of the mathematical apparatus and tools used in practice and methods for stimulating the work of medical and administrative personnel, which leads to high staff turnover.

As follows from the above, with the current trend of financial security of dental services for citizens of the Russian Federation at the expense of compulsory health insurance funds and almost one hundred percent demand for it from the population, the demand for paid dental services for the population will grow, and along with it, competition between CDOs for the patient will increase. This conclusion is confirmed by dentists who combine dental practice in public and private dental medical organizations.

The object of research in this article is the business process of developing a commercial dental clinic that provides paid dental services. The subject of research in this article is the socioeconomic processes, models, and tools for CDO management in the provision of paid dental services.

In the study by Sokolov & Kostyrin [27], a methodology was created for economic and mathematical modeling of management processes for the development of medical organizations, including an algorithm, a block diagram of the algorithm, and tools (information support and software), which makes it possible to make managerial decisions in real time regarding the CDO income, cost, tariffs for paid dental services, and the volume of their provision to patients, considering their optimal combination. Optimization is performed for each dentist and for the entire CDO as a whole. As proved in several studies [26, 28, 29], the growth of gross domestic product (GDP) and the well-being of the entire Russian society significantly depend on the quality, good organization of labor, scientifically based motivation, and material and moral incentives for work. Working citizens are such a source of development for the Russian economy and the well-being of its population, and in the prism of this article, CDO medical professionals and non-medical personnel act as such. A unique comprehensive system for the effective management of paid medical services in budgetary clinics was developed by Kostyrin E.V. [28, 29], which ensures a significant increase in the financial results of a medical organization through the use of a progressive system of labor incentives for medical personnel. The above publications show that with the introduction of progressive labor stimulation technology into medical practice, the volume of paid services provided to the population increases, whereas their cost and price decrease. The developed comprehensive system for the effective management of paid medical services, including an economic and mathematical model, information support, and software, makes it possible to increase the wages of medical personnel and, in particular, dentists, the amount of material incentives for non-medical personnel work, and the deductions for the further development of the medical organization. These funds can be used to purchase up-to-date, highly efficient, and high-tech medical equipment for departments of medical organizations, improve the qualifications of medical and non-medical personnel, acquire modern medicines, and master advanced technologies and methods of diagnosis, treatment, and rehabilitation.

This research developed an economic and mathematical model and tools for managing Moscow CDOs providing paid dental services to patients and presented tools for their implementation in dental practice. The purpose of this research is to develop an economic and mathematical model for stimulating dentists' work, implement a methodology for mathematical modeling and analysis of the management processes of Russian CDOs in practice, and develop a

progressive system for stimulating dentists' work, representing the dependence of the percentage of deductions for increasing employee salaries from income as a result of the provision of paid medical services on the absolute value of this income.

The research hypotheses include the following:

1. The development and practical implementation of an innovative business model for CDO development makes it possible to increase clinic income, dentists' salaries, deductions to labor incentives for administrative and management personnel, and total profit.

2. The introduction of an instrumental complex for managing material remuneration for employees of medical organizations based on economic and mathematical models into everyday medical practice and a progressive system of labor incentives for medical personnel makes it possible to improve the quality of medical care to the population, ensure an increase in the efficiency of everyday medical activities, and increase the affordability of medical care to the population due to reduced tariffs with an increased volume of paid medical services, ensuring an increase in the material and moral interest of personnel in increasing labor productivity, involving the entire workforce in the process of managing a medical organization, fulfilling their needs for the acquisition of advanced medical equipment and medicines, based on the amount of financial resources transferred by each department and dentist to the development fund of the medical organization.

3. The innovative business model increases the interest of all personnel in CDO development, equipping dentists' workplaces with high-tech, advanced equipment that meets all requirements, and makes investments in CDO development an attractive way of investing capital.

2. Literature Review

An analysis of scientific publications by Russian researchers devoted to the issue of digital transformation in the economic development of medical organizations, including the CDC [25, 37], showed that the authors underestimated the problems of financing, building development trajectories aimed at achieving economic efficiency with limited own sources of financing, and the use of expensive borrowed funds and are now focused on issues of management and assessment of the quality of dental treatment.

The problems of financial management of medical organizations, process management, formation of tariffs for paid services, including dental services, resource availability of medical organizations, issues of the quality of labor, material, financial, and management resources, their mathematical description and analysis, and a number of socially significant problems of the population of the Russian Federation related to the impact of dangerous infectious and non-infectious diseases of working-age citizens on the economic losses of the state due to forced disability are mainly examined in the studies of Sukhina et al. [30], Morozko et al. [38], and Gasparian et al. [39]. However, in these publications, little attention is paid to the study of promising trajectories of economic development of CDOs, their mathematical description, the interaction of various participants in the provision of dental services, and the representation and modeling of their interests as small business entities.

Scientific studies evaluate the relationship between dental services and their quality, calculate the profitability of a dental organization, and assess the impact of dentistry on a person's quality of life [23, 40, 41]. Thus, in the study by Choi et al. [42], a model was built that considers a comprehensive assessment of the volume of dental services, their quality, and CDO performance. Lo Russo et al. [43] presented a comparative cost analysis of removable complete dentures manufactured using traditional, partial, and complete digital processes. Taylor et al. [44] examined differences in the economic outcomes of treating patients who received subsidized complete dentures in private and public dental clinics and determined the break-even points for a dental clinic in physical and monetary terms.

A.V. Breusov considered models for stimulating the work of medical personnel, resource-saving technologies, personnel management, and increasing the economic efficiency of prevention, diagnosis, and treatment of patients and their subsequent rehabilitation [45-47]. His studies lack scientifically substantiated trajectories of the economic development of CDOs in the context of digital transformation and the instability of the dental services market associated with external factors, economic shocks, and sanction restrictions. Thus, the literature review showed a lack of studies aimed at analyzing and assessing the economic efficiency of CDO development, with regard to existing and promising digital technologies, process management of financial flows in dental activities, awareness of the need to develop a labor incentive mechanism that is adequate to the current state of the industry, and the prospects for its development for all subjects of dental services: investors, dental business owners, administrators, dentists, their assistants and aides, and service personnel.

Studies by Russian and foreign specialists in the field of healthcare organizations, mathematicians, and economists do not present economic and mathematical models of the processes of managing financial flows and developing dental organizations, and they do not consider progressive technologies for stimulating the work of dentists, dental technicians, administrative and managerial personnel, and support service employees. They also lack a complete and consistent description of the processes of providing dental services to the population using the methodology of functional modeling and the principles of structural system analysis and design.

Currently, there is no universal approach to the development of scientifically grounded economic and mathematical models and mechanisms for assessing CDO performance; the problems of economic and mathematical description of CDO operation have not been completely resolved. The progressive system of stimulating dentists' work also needs to be improved with regard to the development and increasingly profound digital transformation of their daily activities.

3. Material and Methods

A block diagram of the research algorithm is presented in Figure 2. An innovative business model algorithm for CDO development:

Step 1. Determining financial goals and objectives. At this stage, the CDO management and key investors determine the strategic financial goals and key tasks of the CDO, such as the annual volume and affordability of dental services, the level of dentists' salaries, material incentives for the work of administrative and management personnel, return on investment, payback period, and return of capital employed. The main tasks of CDO development are the equipment renewal plan, employee training, personnel policy, marketing research, and labor incentive models.

Step 2. Analyzing the current financial situation. At this stage, it is necessary to analyze the current financial condition of the CDO and predict its development. It is also necessary to clarify the CDO's ability to develop using its own funds or attract sources of borrowed funds if necessary. Bank loans and borrowings require an assessment of the conditions existing in the bank lending market, an assessment of their suitability for a CDO, a search for investors if necessary, and other tasks.

Step 3. If, based on the results of steps 1 and 2, the administrative and managerial staff of the CDO decide that the goals stated in paragraphs 1 and 2 are achievable, a CDO budget is developed for the short, medium, and long term, which considers labor incentive models, models for managing the financial results of the CDO, and the costs of practical implementation of the developed models.

Otherwise, if, based on the results of steps 1 and 2, the administrative and managerial staff of the CDO decide that the goals stated in paragraphs 1 and 2 are not achievable, the employees begin to revise the goals and objectives and (or) expand the planning horizon to mitigate the requirements of investors and administrative and management personnel to achieve goals, consider additional factors influencing the activities of the CDO, and search for additional sources of funding. Next, new goals are set and the transition to step 1 is performed.

Step 4. Developing an innovative business model, including an economic and mathematical model for maximizing dentists' salaries in relation to the actual volume of dental services with material incentives for the work of administrative and managerial personnel, deductions for CDO development, and the costs of their provision.

Step 5. For developing the CDO, equipping dentists' workplaces with new high-tech equipment, improving their qualifications, and providing better working conditions, including procurement and medicine provision, it is required to attract additional sources of funding (loans, credits, additional issue of bonds, shares, and securities), a debt repayment plan is developed.

Step 6. Investing in CDO activities in accordance with established goals and risk management models. At this stage, investments are made in expanding the CDO on the basis of developed debt repayment plans and an equipment renewal program, expanding the CDO activities, and equipping the dentists' workplaces. Furthermore, at this stage, possible risks are calculated and measures are developed to eliminate them or reduce their impact on CDO activities.

Step 7. Reviewing and adjusting plans periodically. At this step, the developed plans are changed in compliance with the new values of the influencing factors that were not considered during the development and practical implementation of the CDO development plans and the innovative business model. Based on the results of the revision of plans, new financial goals and CDO development objectives are set, and the algorithm is repeated starting from step 1 (see Figure 2).
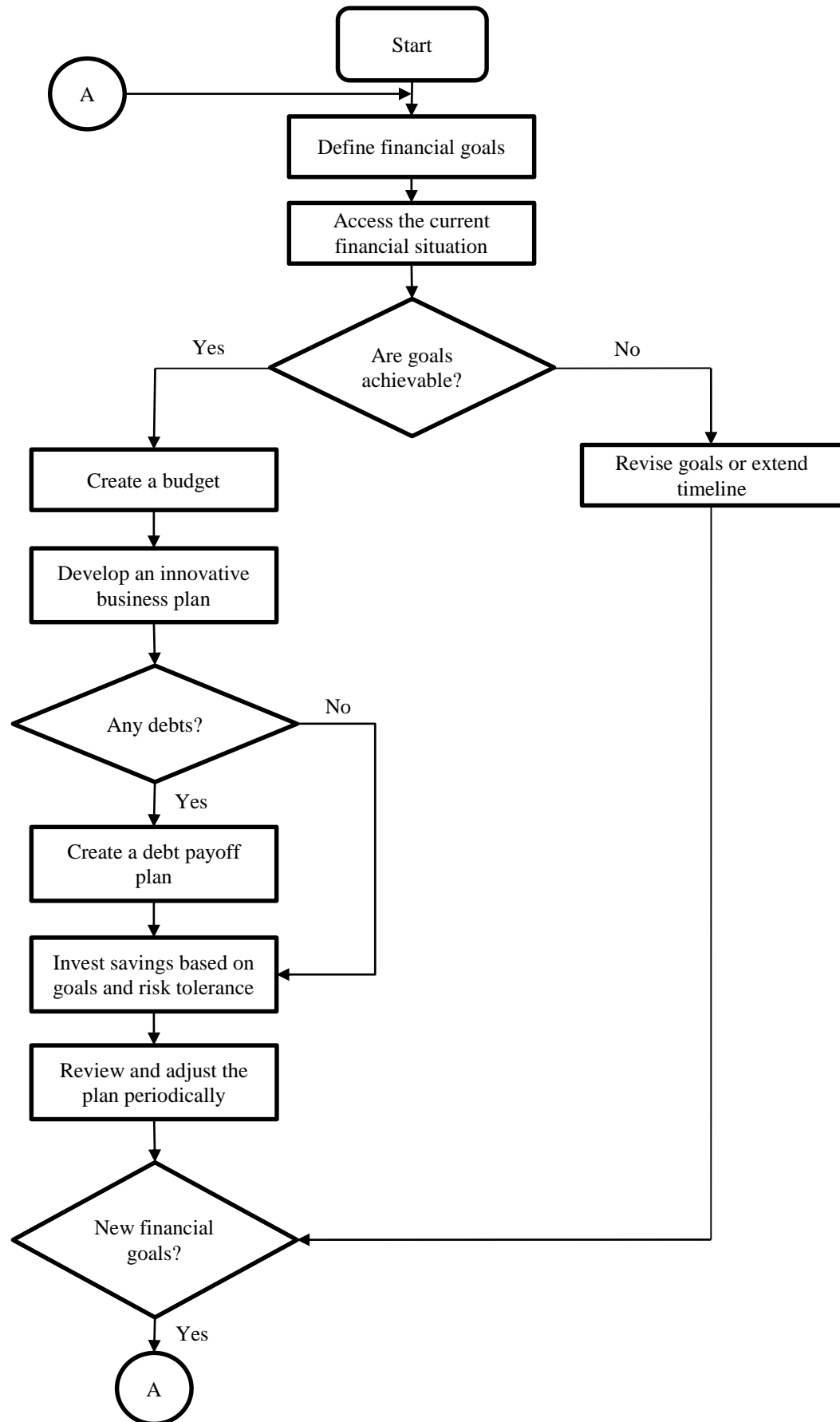
Figure 2. Research flowchart

A common practice for organizing the provision of paid dental services by the CDO is to provide financial incentives for the dentists' work as a percentage of the total volume of dental services provided and the revenue received from their

provision. Therefore, the target function of the innovative business model for CDO development is the amount of remuneration from the revenue received as a result of providing paid dental services to the population, allocated to the dentists' salaries [29]:

$$S_j = \theta_j \cdot RR_j / 12 \rightarrow max \tag{1}$$

where S_j is the salary of the j-th dentist of the CDO;

θ_j – percentage of revenues from the provision of paid dental services by the j-th dentist of the CDO, allocated to the dentists' salaries;

RR_j – revenue of the j-th dentist received from the provision of paid dental services.

To provide incentives for dentists to increase the volume of paid dental services, a progressive salary scale must be created. In other words, the percentage of the j-th dentist's revenue allocated to his/her remuneration should depend on the size of this revenue, i.e., $\theta_j(RR_j)$. All additional revenue earned by dentists above the base amount is distributed between them and the CDO in established proportions, which is determined by the coefficient of revenue redistribution between dentists and the CDO (let us denote it λ). Then, the monthly income of the j-th dentist from the provision of paid dental services exceeding the basic amount is redistributed between him/her and the CDO in the following proportions:

$$S_j = (RR_j / 12) \cdot \theta_{bj} + \lambda \cdot (RR_j - RR_{bj}) / 12 \tag{2}$$

This part of the revenue is allocated to dentists' salaries.

The part of the revenue allocated to CDO development equals:

$$D_{develop,j} = (RR_j / 12) \cdot (1 - \theta_{bj}) + \lambda \cdot (RR_j - RR_{bj}) / 12 \tag{3}$$

From Equations 2 and 3, we can derive the dependence of the parameter θ_j on revenue growth due to an increase in the volume of paid dental services provided, i.e., create a progressive system of material and moral incentives for the work of the CDO dentists, in which the amount of salary depends on the revenue from the provision of paid dental services. At the same time, the value of the θ_j percentage does not remain constant but grows with the growth of paid dental services provided. This means that the increase in salaries occurs under the influence of a double effect: on the one hand, depending on the growth of revenue due to an increase in the volume of paid dental services, and on the other hand, on the change in the percentage allocated to the dentists' salaries. Let us divide (2) by the base revenue and obtain the percentage allocated to dentists' salaries [29]:

$$\theta_j\left(RR_j\right) = \frac{(RR_j/12)\cdot\theta_{bj}+\lambda\cdot(RR_j-RR_{bj})/12}{RR_{bj}/12} \tag{4}$$

where RR_{bj} is the base revenue received from the provision of paid dental services by the j-th dentist;

θ_{bj} – the base percentage of revenue allocated to the salary of the j-th dentist with the base annual volume of paid dental services provided.

Considering the above, the economic and mathematical model related to nonlinear programing problems, aiming to maximize dentists' salaries and linking material labor incentives for non-medical personnel and deductions for CDO development with the actual volumes of these services and the costs of their provision, has the following view [27-29]:

Objective function

$$
\begin{aligned}
S_{jk}\left(V_{paidijk}, \xi_{jk}\right) = \\
= \frac{1}{12} \cdot \frac{\sum_{i=1}^{n_{jk}} V_{paidijk} \cdot P_{paidijk}}{\sum_{k=1}^{K_j}\sum_{i=1}^{n_{jk}} V_{paidijk} \cdot P_{paidijk}} \\
\cdot \left[\sum_{i=1}^{n_{jk}} V_{paidijk} \cdot \left(P_{ijk}^0 - \varepsilon_{paidij} \cdot \left(P_{paidijk} - P_{paidijk}^0\right)\right) - \sum_{i=1}^{n_{jk}} V_{ijk} \cdot C_{varijk} - C_{constjk} + \xi_{jk} \right. \\
\left. \cdot \sum_{i=1}^{n_{jk}} V_{ijk} \cdot \left(C_{totij}^0 - C_{totijk}\right) \right] \rightarrow max,
\end{aligned}
\tag{5}
$$

Limitations

$$\sum_{i=1}^{n_{jk}} V_{\text{paid}ijk} \cdot \left(P_{ijk}^0 - \varepsilon_{\text{paid}ij} \cdot \left(V_{\text{paid}ijk} - V_{\text{paid}ijk}^0 \right) \right) - \sum_{i=1}^{n_{jk}} V_{ijk} \cdot C_{\text{var}ijk} - C_{\text{const}jk} + \xi_{jk} \cdot$$
$$\sum_{i=1}^{n_{jk}} V_{ijk} \cdot \left(C_{\text{tot}ij}^0 - C_{\text{tot}ijk} \right) \geq R_{jk} \cdot C_{\text{tot}jk} \tag{6}$$

$$\sum_{i=1}^{n_{jk}} V_{\text{paid}ijk} \leq \frac{B_j \cdot \tau_j}{S_{\text{av}j}} \forall j, k \tag{7}$$

$$R_{ijk} \cdot C_{\text{tot}ijk} \leq P_{ijk}^0 - \varepsilon_{\text{paid}ij} \cdot \left(V_{\text{paid}ijk} - V_{\text{paid}ijk}^0 \right) \leq P_{ijk}^u \tag{8}$$

$$V_{\text{paid}ijk} - \text{integer-valued } \forall i, j, k, \tag{9}$$

$$V_{\text{paid}ijk} \geq V_{\text{paid}ijk\text{warranty.}} \forall i, j, k, \tag{10}$$

$$V_{ijk} = 0 \ with \ k \in N \tag{11}$$

$$0 \leq \xi_{jk} \leq 1 \tag{12}$$

$$\text{Bonus}_{jk} = \varphi_j \cdot \theta_{jk} \cdot R_{jk} \cdot C_{\text{tot}jk} - V_{\text{paid}ijk\text{waranty.}} \tag{13}$$

Equations 5 to 13 use the following notation:

S_{jk} – salary of the *k*-th dentist of the *j*-th department, RUB;

$V_{\text{paid}ijk}$ – volume of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO, units;

ξ_{jk} – the coefficient of redistribution of the financial result from reducing the cost of the volume of services between the salary of the *k*-th dentist of the *j*-th department of the CDO and deductions to the CDO development fund;

$\theta_{jk} = \dfrac{\sum_{i=1}^{n_{jk}} V_{\text{paid}ijk} \cdot P_{\text{paid}ijk}}{\sum_{k=1}^{K_j} \sum_{i=1}^{n_{jk}} V_{paidijk} \cdot P_{paidijk}}$ – labor participation coefficient (LPC), a percentage of the income for the salary of the *k*-th dentist of the *j*-th department of the CDO (salary along with deductions for social insurance);

n_{jk} – the number of types of paid dental services provided by the *k*-th dentist of the *j*-th department of the CDO, units;

$P_{\text{paid}ijk}$ – price of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO, RUB;

K_j – number of dentists of the *j*-th department of the CDO, units;

P_{iik}^0 – price of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO in the basic version of the simulation, RUB;

$\varepsilon_{\text{paid}ij}$ – price elasticity coefficient of demand for the *i*-th paid dental service of the *j*-th department of the CDO;

$V_{\text{paid}iik}^0$ – volume of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO in the basic version of the simulation, units;

$C_{\text{var}ijk}$ – specific variable costs attributable to the *i*-th dental service provided by the *k*-th dentist of the *j*-th department of the CDO, RUB;

$C_{\text{const}jk}$ – constant costs of the *k*-th dentist of the *j*-th department of the CDO, RUB;

$C_{\text{tot}iik}^0$ – the total prime cost of the *i*-th dental service provided by the *k*-th dentist of the *j*-th department of the CDO in the basic version of the simulation, RUB;

$C_{\text{tot}ijk}$ – the total prime cost of the *i*-th dental service provided by the *k*-th dentist of the *j*-th department of the CDO, RUB;

R_{jk} –return on investment in equipping the workplace of the *k*-th dentist of the *j*-th department of the CDO;

$C_{\text{tot}jk}$ – the total prime cost of paid dental services provided by the *k*-th dentist of the *j*-th department of the CDO, RUB;

B_{jk} – standard working hours of the *k*-th dentist of the *j*-th department of the CDO, min;

τ_{jk} – the labor utilization rate of the *k*-th dentist of the *j*-th department of the CDO for the provision of paid dental services;

$S_{\text{av}jk}$ – average working time expenditures of the *k*-th dentist of the *j*-th department of the CDO for the provision of one dental service to the patient, min;

R_{ijk} – the profitability of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO;

P_{tik}^{u} – the upper limit of the price of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO, determined on the basis of the demand for the dental service in question using marketing pricing methods, RUB;

$V_{\text{paid}ijk\text{waranty}}$ – the volume of the *i*-th paid dental service provided by the *k*-th dentist of the *j*-th department of the CDO, conditioned by the need for the provision of dental services under warranty obligations, units;

N – a set of dentists who do not provide the *i*-th paid dental service in the *j*-th department of the CDO (due to the lack of a license for this type of dental services, inappropriate qualifications of the dentist or for other reasons);

$Bonus_{jk}$ – the amount of performance-based compensation of the *k*-th dentist of the *j*-th department of the CDO (bonus) for the reporting period (year, quarter, etc.), RUB;

φ_j – the share of the CDO funds allocated for bonuses to employees of the *j*-th department of the CDO.

Thus, as follows from Equation 5 and the analysis of the economic – mathematical model (5)–(13), the controlled variable is the material incentive for dentists, and the influencing factors (control variables) are paid dental services provided to the population by the dentist, and the redistribution coefficient from reducing the prime cost of dental services between the dentist's labor incentives and deductions to the CDO development fund, which is determined by agreement between the workforce and the administrative and managerial staff of the CDO.

The methodological basis of the research was formed by the studies of Russian and foreign specialists in the field of economic and mathematical modeling and decision-making, including nonlinear programing system analysis, information approach to systems analysis, sociometric research methodology, and personnel management. The material basis for the research was formed by the current regulations, statistical digests: *Russian Statistical Yearbook, Healthcare in Russia, Resources and Activities of Healthcare Institutions*, reports of the Ministry of Health of the Russian Federation, the Central Research Institute for Organization and Informatization of Healthcare, and the results of an analysis of dental organizations' business processes, development of Russian and foreign medical dental organizations, results of questionnaires and surveys of dental organizations' personnel, interviews with top managers, marketing research, analysis of data resources about the activities of Russian and foreign state and commercial dental clinics, results of empirical research by Russian and foreign authors, and information obtained from open sources.

Belonging of a dental medical organization to commercial dental clinics that provide paid dental services to the population is a criterion for selection (inclusion) in the material base of the research. The total number of CDOs in Russia, which, according to their organizational and functional characteristics, are target organizations for introducing into dental practice the created innovative business model for the development of commercial dental clinics, is approximately 28,000, and 3,315 such medical institutions operate in Moscow, which is 11.84% of the total number of CDOs in Russia. Non-inclusion criterion comprises state dental medical organizations providing dental services in the compulsory health insurance system and (or) paid dental services. The exclusion criterion involves commercial dental clinics whose organizational and managerial structure does not allow the introduction of innovative business processes into dental practice or whose effectiveness of the implementation of such methods is lower than the financial costs of their implementation.

A comparative analysis of the scientific results obtained by the authors and those of other scholars and specialists involved in certain aspects of the problems raised in the article is presented in Table 1.

Table 1. Comparison with other studies and scientific knowledge increment

No.	Scientific result	Scientific novelty
1	An economic and mathematical model has been developed for maximizing dentists' salaries in the relationship between the actual volumes of dental services with material labor incentives for administrative and managerial personnel, deductions for CDO development, and the costs of their provision.	In contrast to labor incentive models used in practice ([26, 29, 47]; etc.), the basis of this economic and mathematical model is a progressive system of incentives for dentists' work, enabling to increase material incentives for employees depending on the increase in the volume of dental services provided and their prices concerning the assessment of investment in equipping the dentists' workplaces with the necessary dental equipment, improving their qualifications, purchasing the necessary materials and medications, and considering deductions for the CDO development, which makes it possible for the entire team to participate in managing a dental organization, allocate funds to its further development, and invest in the expansion of the CDO and the dental care provided to the population.
2	An innovative business model for CDO development has been developed, which makes it possible to link profits from the sale of dental services with additional staff remuneration, investment in expanding the range of dental care provided, the purchase of additional dental equipment, equipping the dentist's workplace, and deductions for CDO development and deductions to debt repayment on attracted investors' funds (credit and loan facilities).	In contrast to well-known models of process management of enterprises [3, 11, 13] and innovative business models for the development of medical dental organizations, this approach makes it possible to simultaneously consider the effectiveness of investment in the CDO expansion, repay debt on funds raised for the CDO expansion, and the volume of dental services provided, with regard to the progressive system of dentists' labor incentives, investors' interests, and dental business owners, as well as key parameters of bank loans to finance the activities of the CDO and its development.

| 3 | A debt repayment plan for a bank loan has been developed, which considers the individual contribution of each dentist to CDO development at the expense of borrowed funds, loan parameters, and the interests of investors and owners of the dental business. | This approach differs from other methods and plans for business expansion, including dental (Vesinurm et al. [18]; Printz-Markó et al. [19]; Losev et al. [48]; etc.) in that management decisions are made in a three-dimensional coordinate system: the investors' interests, labor team, and administrative personnel, which makes the debt repayment plan in mutual connection with the financial results of the CDO flexible, adaptive, and enables quick response to changes in lending parameters and the CDO performance results and each dentist individually. This allows the entire team to participate in expanding the dental business, rather than only administrative and management personnel. Investors and owners should consider the financial stability, solvency, and performance of the CDO and each employee. In addition, a distinctive feature of the author's approach is that additional profit from increasing sales volumes is allocated to stimulate labor or, in agreement with the workforce, to early repay debt from external sources of funding (credits, loans, investment), which makes this model closed, complex, and dynamic. |
| 4 | A comprehensive toolkit has been developed for managing CDO cash flows, revenues, and expenses from the sale of dental services. | The proposed model differs from the models used for managing financial flows of enterprises ([13, 30, 38], etc.), in that it enables management decision makers to coordinate investment programs and plans depending on prices for dental services, the volume and cost of these services, which contributes to the growth of economic efficiency (profitability) of investment in the dental business, material labor incentives for dentists, and deductions to the CDO development fund. |

4. Results

The developed economic and mathematical model for dentists' labor incentives was implemented in practice as exemplified by the results of the activities of a typical CDO in Moscow for the period from September 2022 to August 2023 (for one calendar year). The staffing schedule and initial data necessary for modeling the CDO development under consideration are presented in Table 2.

Table 2. Staffing schedule and initial data necessary for modeling CDO development under consideration

No	Position	Actual working hours per week, hours	Actual working hours per month, hours	Average monthly salary regarding actual services provided and actual working hours*, RUB	Volume of services provided from September 2022 to August 2023	Standard volume of dental services with dentists' full working load from September 2022 to August 2023	Working time spent on one service, min [49, 50]	Average dental costs, RUB	Standard duration of the working week, hours	Standard average monthly salary in Moscow, RUB
1	2	3	4	5	6	7	8	9	10	11
1	Administrative and management personnel	36.0	154.44	159,600	1,113	9,669	11.3±2.8	850**	40	177,332
2	Dentist-orthopedist	12.5	53.62	105,134	561	3,190	30.6±9.6	14,121	33	277,554
3	Dental therapist R.	19.5	83.66	130,650	603	2,398	40.7±10.1	6,500	33	221,446
4	Dental therapist F.	11.5	49.34	77,170	356	2,398	40.7±10.1	6,500	33	221,446
5	Dentist-surgeon	5.5	23.30	38,234	209	7,398	15.6±4.9	7,857	39	271,113
6	Orthodontist	7.0	30.03	48,673	440	1,684	53.5±10.6	33,840	33	229,464

Note: *for administrative and management personnel and dentists, the CDO in question is not the main place of work; therefore, the average monthly salary is indicated for the services actually provided, regarding the actual working hours.

**The administrative and managerial personnel of the CDO in question provide only consulting and radiology services rather than dental services: radiovisiography (in the area of a segment of 1 or 2 adjacent teeth), orthopantomography (survey X-ray of teeth and jaws), and description and interpretation of computer tomograms. Therefore, the average tariff for radiology services is indicated.

Column 2 of Table 2 shows the positions of non-medical and medical personnel of the CDO in question according to the current actual staffing schedule. Thus, the clinic employs five dentists, including two dental therapists and one registrar (non-medical personnel), whose responsibilities include receiving patient requests, processing them, analyzing them, and making appointments with the appropriate medical specialist according to the established appointment

schedule. Column 3 of Table 2 shows the actual duration of the employees' working week, determined by a random sample study for the period from September 2022 to August 2023, since the medical specialists of the analyzed CDO have an irregular working week, the duration of which largely depends on the availability of patient appointments with the doctor to avoid unnecessary downtime in the dentists' work. Analysis of column 3 of Table 2 reveals that the administrative and management personnel have the longest working week (36 hours, see line 1, column 3 of Table 2), and the dental surgeon has the shortest working week (only 5.5 hours per week, see line 5, column 3 of Table 2). The actual length of working time per month (column 4 of Table 2) is calculated by multiplying the actual length of the working week (column 3 of Table 2) by the average number of weeks per month for the period under review, which is 4.29. Thus, as shown in the first line of column 4 of Table 2, the actual working time per month is 154.44 hours = 36.0 hours (line 1, column 3 of Table 2) multiplied by 4.29 weeks in a month. The calculation was performed similarly for the remaining lines in column 4 of Table 2.

The average monthly salary, regarding the actual length of the working week (column 5 of Table 2), is determined by multiplying the standard average monthly dentists' salary in Moscow (column 11 of Table 2) by the share of actually worked time in the standard length of the working week (column 10 of Table 2). In particular, for administrative and managerial personnel, the average monthly salary is 105,000 rubles, which is determined by multiplying 116,666 rubles (the standard average monthly wage, see line 1, column 11 of Table 2) by 0.9, where 0.9 is the share of the actual working week (36 hours) in the standard working week (40 hours, see line 1, column 10 of Table 2), i.e., 0.9 = 36 hours: 40 hours.

Column 6 of Table 2 shows the volume of services provided from September 2022 to August 2023 by the management of the CDO, and column 7 of Table 2 presents the standard volume of dental services with dentists' full working load per one rate for the same period. It can be seen that the standard volume of dental services significantly exceeds the actual figures. For example, for an orthopedic dentist, the standard volume is 3,190 services per calendar year (from September 2022 to August 2023), but 561 services were actually provided during this period, i.e., 5.69 times less. A dental therapist provided 603 services with a standard volume of 2,398 services (fourfold as much); for a dental surgeon, the standard volume is 7,398 dental services per year with 209 services actually provided (less than 35.4 times the standard), and for administrative and managerial personnel, the standard volume is the largest among the set under consideration and is equal to 9,669 services, which exceeds the actual volume of services provided (1,113 services, see the first line of column 6 of Table 2) by 8.69 times.

Thus, *CDOs* have significant opportunities and reserves for developing and expanding their activities. However, it is important to consider that in Equation 3 of the economic and mathematical model (1)–(9), the main limitation on the volume of paid dental services provided is imposed by the throughput of the dentist's workplace (universal dental workstation), since only one workplace is used by dentists in the CDO to provide the entire range of dental care. Provided it is fully loaded from 9 a.m. to 10 p.m., i.e., 13 hours a day, including on weekends, except holidays, the number of which in the period under review from September 2022 to August 2023 was 22, the working time budget for a universal dental workstation (dentist's workplace) for 12 months (from September 2022 to August 2023) was (30 calendar days in September 2022 + 92 calendar days in the fourth quarter of 2022 + 90 calendar days in the first quarter of 2023 + 91 calendar days in the second quarter of 2023 + 31 calendar days in July 2023 + 31 calendar days in August 2023 – 22 holidays in the period under review) 13 hours per day = 4,459 hours. This value exceeds the actual working hours of dentists for 12 months by half as much (4,459 hours: 239.95 hours (actual working hours of dentists per month, the sum of lines 2–6 of column 4 of Table 2): 12 months = 1.5). Therefore, in the practical implementation of the economic and mathematical model for CDO development (1)–(9), a monthly increase in the volume of services provided by dentists of the considered CDC during the year is simulated by 50% of the base version of modeling (the actual volume of dental services provided over the period under review from September 2022 to August 2023, i.e., for one calendar year).

The standard volume of dental services presented in column 7 of Table 2 is equal to the ratio of the position's working time budget to the average working time spent on one dental service (see column 8 of Table 2), taken from scientific articles [49, 50]. To calculate the working time budget, it is necessary to be guided by the standard working hours of dentists, which are governed by Appendix No. 2 to Decree No. 101 of the Government of the Russian Federation dated February 14, 2003, "On the working hours of medical workers depending on their position and (or) specialties". Thus, according to the specified regulatory legal act, the working hours of orthopedic dentists, orthodontists, and dental therapists make 33 hours per week. An exception is provided for dental surgeons, for whom Article 350 of the Labor Code of the Russian Federation establishes a 39-hour working week. These values are indicated in the corresponding lines of column 10 (Table 2).

Consequently, for an orthopedic dentist, the value of 3,190 dental services for the period from September 2022 to August 2023 was obtained as follows: 3,190 services = 1,627.2 working hours per year with a 33-hour working week ·

60 min/hour: 30.6 min (average time spent on providing one dental service by an orthopedic dentist, see line 2, column 8 of Table 2). The standard workload for other dentists was calculated in a similar way (see column 7 of Table 2).

As follows from the analysis of the data presented in column 10 (Table 2), the total standard working week of all CDO dentists is $4 \cdot 33 + 39 = 171$ hours. This means that *the standard working time of all dentists over the year* is equal to 171 hours · 4.29 weeks in one month · 12 months = 8,803.03 hours, which *exceeds twice the throughput of the dental chair* (8,803.03 hours: 4,459 hours = 2 times). *Thus, the CDO development requires the extremely urgent acquisition of another dentist's workplace.* In other words, although each dentist is underworked and has a reserve for growth in the dental services provided, all dentists working in the CDO in question will be unable to simultaneously increase the volume of dental services they provide without increasing the department capacity through the acquisition of a universal dental workstation for equipping an additional workplace for a dentist.

Moreover, from the viewpoint of ergonomic features in the provision of dental services, it is highly desirable to follow a differentiated approach to equipping dentists' workplaces. Thus, the equipment used in the workplace of dental therapists differs significantly from the equipment used in the workplace of an orthodontist, an orthopedic dentist, or a surgeon. The same applies to doctors in other specialties. Therefore, organizing the work of CDO dentists on one universal dental workstation requires additional efforts to distribute time among doctors of various specialties and does not allow parallel provision of dental services on several universal dental workstations.

As substantiated in previous studies [27–29], material labor incentives for each CDO dentist are more effective than departmental incentives. The results of modeling the work of the dentist therapist R. in the CDO are presented in Table 3.

Table 3. Results of modeling the work of the dentist therapist R. in the CDO for one year

No	Actual volume of paid dental services provided by a dentist per month	Actual annual volume of paid dental services provided by a dentist	Increase in the actual volume of paid dental services provided by a dentist relative to the base volume, share of units	Average tariff for paid dental services, RUB	Unit cost of one dental service, RUB	Income from the sale of the actual volume of paid dental services, RUB	Total cost of the actual volume of paid dental services, RUB	Profit from the sale of the actual volume of paid dental services, RUB	Financial result from reducing the cost of one dental service, RUB	Financial result from reducing the total cost of the actual volume of dental services, RUB
1	2	3	4	5	6	7	8	9	10	11
0	50	603	1.00	6,500.00	2,164.54	3,919,500.00	1,305,216.43	2,614,283.57	0.00	0.00
1	52	628	1.04	6,500.00	2,078.62	4,082,000.00	1,305,371.43	2,776,628.57	85.92	53,958.45
2	54	653	1.08	6,500.00	1,999.27	4,244,500.00	1,305,526.43	2,938,973.57	165.26	107,916.90
3	56	678	1.12	6,500.00	1,925.78	4,407,000.00	1,305,681.43	3,101,318.57	238.75	161,875.35
4	59	703	1.17	6,500.00	1,857.52	4,569,500.00	1,305,836.43	3,263,663.57	307.02	215,833.80
5	61	728	1.21	6,500.00	1,793.94	4,732,000.00	1,305,991.44	3,426,008.56	370.59	269,792.25
6	63	753	1.25	6,500.00	1,734.59	4,894,500.00	1,306,146.44	3,588,353.56	429.95	323,750.70
7	65	778	1.29	6,500.00	1,679.05	5,057,000.00	1,306,301.44	3,750,698.56	485.49	377,709.15
8	67	803	1.33	6,500.00	1,626.97	5,219,500.00	1,306,456.44	3,913,043.56	537.57	431,667.60
9	69	828	1.37	6,500.00	1,578.03	5,382,000.00	1,306,611.44	4,075,388.56	586.50	485,626.05
10	71	853	1.41	6,500.00	1,531.97	5,544,500.00	1,306,766.44	4,237,733.56	632.57	539,584.50
11	73	878	1.46	6,500.00	1,488.52	5,707,000.00	1,306,921.44	4,400,078.56	676.02	593,542.95
12	75	903	1.50	6,500.00	1,447.48	5,869,500.00	1,307,076.44	4,562,423.56	717.06	647,501.40

Table 3. Results of modeling the work of the dentist therapist R. in the CDO for one year (*continued*)

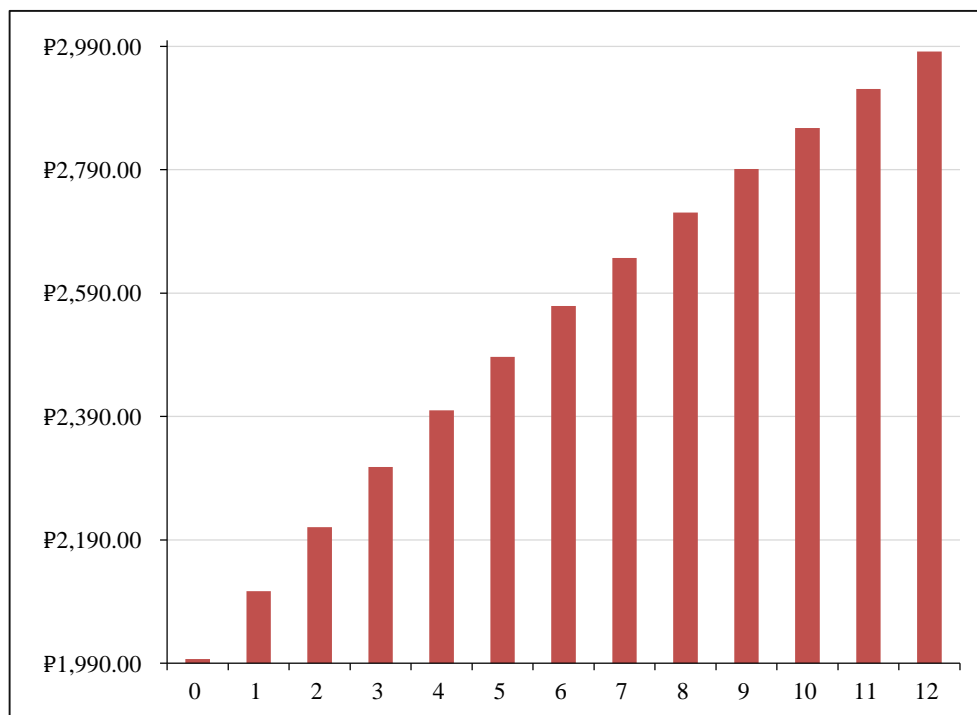| No	Income from the sale of the actual annual volume of dental services, regarding the financial result from cost reduction, RUB	Monthly income from the sale of the actual volume of paid dental services, RUB	Percentage of income allocated to medical personnel's salary, %	Percentage of income allocated to medical personnel's salary, regarding deductions for social insurance (30.2%), %	Percentage of income for labor incentives of non-medical personnel, %	Percentage of income for labor incentives of non-medical personnel, regarding deductions from wages for social insurance (30.2%),	Percentage of income deducted for CDC development, %	Monthly salary of a dentist, RUB	Monthly salary of a dentist, regarding deductions from wages for social insurance (30.2%), RUB	Labor incentives for medical personnel per dental service, RUB
1	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
0	3,919,500.00	326,625.00	40.00	30.72	20.00	15.36	40.00	130,650.00	100,345.62	2,600.00
1	4,135,958.45	344,663.20	41.65	31.99	20.00	15.36	38.35	143,560.25	110,261.33	2,642.96
2	4,352,416.90	362,701.41	43.18	33.16	20.00	15.36	36.82	156,607.72	120,282.43	2,682.63
3	4,568,875.35	380,739.61	44.59	34.25	20.00	15.36	35.41	169,777.23	130,397.26	2,719.38
4	4,785,333.80	398,777.82	45.90	35.26	20.00	15.36	34.10	183,055.75	140,595.82	2,753.51
5	5,001,792.25	416,816.02	47.13	36.20	20.00	15.36	32.87	196,432.06	150,869.48	2,785.30
6	5,218,250.70	434,854.22	48.27	37.07	20.00	15.36	31.73	209,896.42	161,210.77	2,814.97
7	5,434,709.15	452,892.43	49.34	37.89	20.00	15.36	30.66	223,440.34	171,613.17	2,842.74
8	5,651,167.60	470,930.63	50.34	38.66	20.00	15.36	29.66	237,056.39	182,070.96	2,868.78
9	5,867,626.05	488,968.84	51.28	39.38	20.00	15.36	28.72	250,738.04	192,579.14	2,893.25
10	6,084,084.50	507,007.04	52.16	40.07	20.00	15.36	27.84	264,479.51	203,133.26	2,916.29
11	6,300,542.95	525,045.25	53.00	40.71	20.00	15.36	27.00	278,275.70	213,729.42	2,938.01
12	6,517,001.40	543,083.45	53.79	41.31	20.00	15.36	26.21	292,122.06	224,364.10	2,958.53

Figure 3. Labor incentives for medical personnel per one dental service
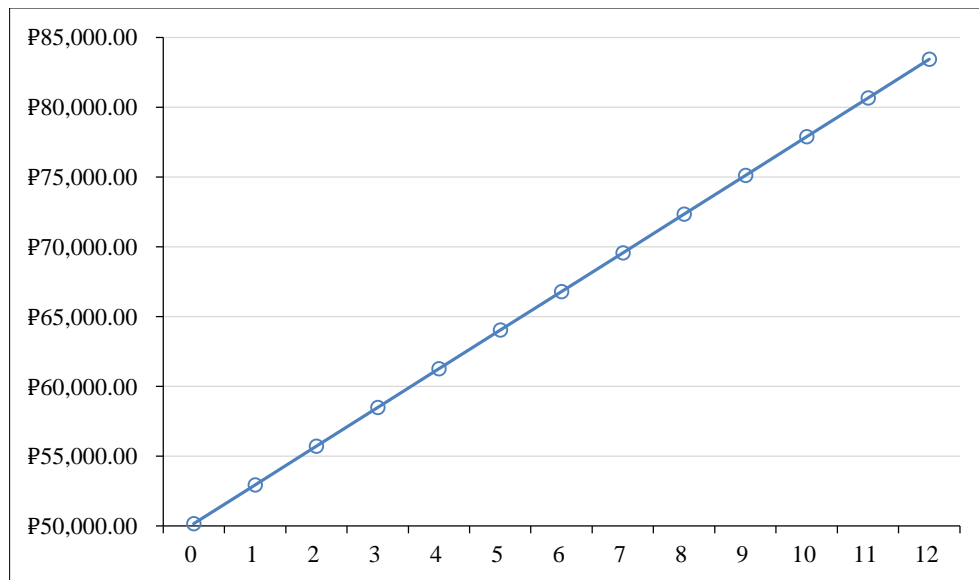
Figure 4. Labor incentives for non-medical personnel per month
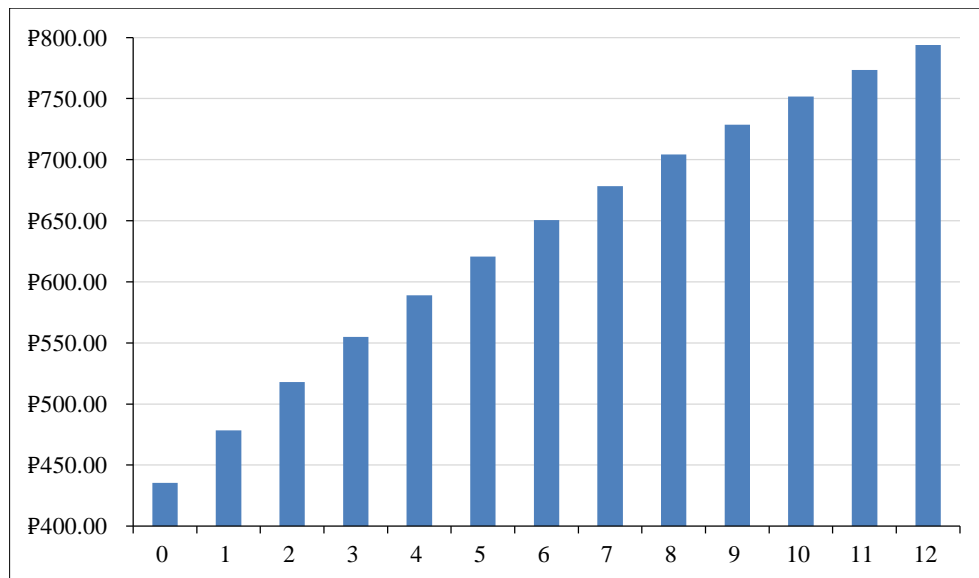
Figure 5. Payment to the lender from one service to cover the loan
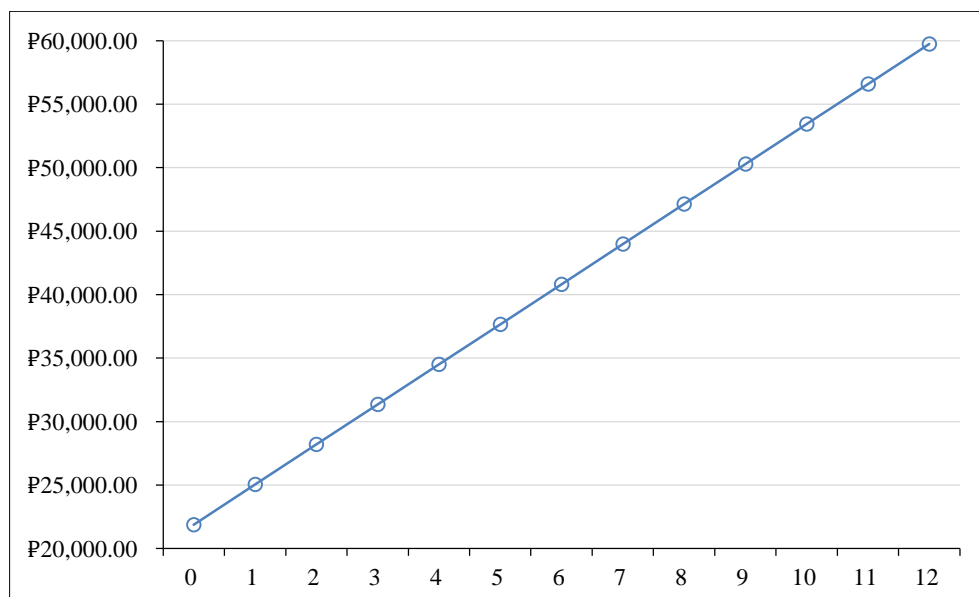
Figure 6. Total payment to the lender per month

Column 1 of Table 3 shows the modeling options considering the monthly uniform increase in the volume of services provided throughout the year. The first modeling option (line 0) is basic and corresponds to the data specified in Table 2. Furthermore, according to the modeling option, the volume of paid dental services provided by a dental therapist per month increases evenly; therefore, in the last modeling option (last line of Table 3), the volume of paid dental services is half as much as that in the basic modeling option (the actual volume of paid dental services provided over 12 months, from September 2022 to August 2023). Thus, the last modeling option (last row of Table 3) is an increase in the volume of paid dental services by half as much relative to the basic modeling option (zero line of Table 2), as shown in column 3 of Table 3.

Column 2 (Table 3) shows the results of the activities of a CDO dental therapist in providing paid dental services to patients per month. The initial data for the basic modeling option are taken from line 3, column 6 of Table 2 (603 services). The indicated value is equal to the actual number of dental services provided by the dental therapist from September 2022 to August 2023. The actual annual volume of paid dental services provided by a dental therapist to the population is given in column 3 (Table 3). For each modeling option, it increases by an average of 4% relative to the previous option (see column 4 of Table 3).

Column 5 (Table 3) shows the average price of paid dental services by a CDO dental therapist. The affordability of dental services for the population of the Russian Federation is directly ensured by a decrease in average prices for dental care with an increase in actual volumes, which leads to the emergence of new patients who are willing to pay the specified price for the service, resulting in an increase in the actual volumes of dental services and income from their provision to the population. The possibility of reducing prices for dental services arises due to a significant difference between the average price for dental services (column 5) and the unit cost (column 6), according to the calculation options. The developed economic and mathematical model for dentists' labor incentives (Equations 5 to 13) makes it possible for the CDO, because of the use of the demand elasticity coefficient for the price of paid dental services (ε_{paid}, see Equations 5 and 6), to redistribute reductions in prices (discounts) between the patient and the CDO and calculate in real time a set of discount modeling options depending on the specific situation, supply, and demand conditions in the dental services market. In this example, with an increase in the volume of paid dental services, a decrease in tariffs for paid dental services is not modeled, i.e., for all modeling options, the average tariff for paid dental services by a dental therapist is 6,500 rubles (see column 5 of Table 3).

Column 6 gives the unit cost of one dental service. Column 7 indicates the total income from the sale of the actual volume of paid dental services of a CDO dental therapist. Income from the sale of the actual volume of paid dental services (column 7) is calculated for each modeling option by multiplying the corresponding value in column 3 and the value in column 5. Column 8 indicates the total cost of the actual volume of paid dental services, and column 9 shows the profit from the sale of the actual volume of paid dental services, as determined by the difference between the values presented in the corresponding lines of columns 7 and 8.

Column 10 presents the values of the financial result from reducing the cost of one dental service, and column 11 shows the financial result from reducing the cost of the actual volume of services provided by the dental therapist, calculated as the difference between the total cost of the actual volume of paid dental services with a corresponding proportional increase in the total cost of the actual volume of paid dental services and the fact that in the structure of the cost of dental services, the share of variable expenditures (costs of materials and equipment maintenance) is only 2.97%. Column 12 of Table 3 shows the income from the provision of the actual volume of paid dental services associated with the effect of reducing costs and the fact that the average price (column 5) is significantly (almost by a factor of 5) higher than the unit cost of one dental service (column 6).

Monthly income (column 13) is calculated for all modeling options by dividing the corresponding values in column 12 by the number of months in the period under consideration from September 2022 to August 2023, i.e., by 12.

The percentage of the monthly income in the base version of modeling, or LPC, of the *k*-th dentist of the *j*-th department of the CDO (θ_{jk}), which is allocated to the salary of the dental therapist (column 14), is equal to the share of salary costs in the income structure. As shown above, average prices for paid dental services are almost five times higher than their unit cost. Therefore, stimulating an increase in the actual volume of dental services is very effective from the standpoint of increasing the salaries of all medical personnel of the CDO and from the standpoint of accumulating financial resources for CDO development (purchase of effective and efficient medical equipment, a universal dental workstation (dentist's workplace), and high-quality medicines).

In this regard, the authors propose to apply a progressive system of dentists' remuneration in the CDO with a step determined by the ratio of the effect of reducing the cost of one dental service (column 10 of Table 3) to labor incentives for medical personnel per dental service (column 21 of Table 3) and by adding the result obtained to the base percentage of income allocated to stimulate the work of medical personnel (40%, see the first line of column 14 of Table 3). At the same time, the coefficient of redistribution of the financial result from reducing the cost of services between the salary of a CDO dental therapist and deductions to the CDO development fund (in the context of this article, contributions to

the investor) is equal to 0.5, i.e., parameter ξ_{jk} =0.5 (see Equations 5 and 6 of the economic and mathematical model (5)–(13)). This means that the increase in financial results from the reduced cost of dental services is distributed equally between the increase in the salary of the CDO dental therapist and the increase in deductions to the investor. Thus, for the second line of column 14 (Table 3), value 40.41% = 21.37 rubles (the effect of reducing the cost of one dental service; see the second line, column 10 of Table 3) · 0.5 (the coefficient of redistribution of the financial result from reducing the cost of the volume of services between the salary of a CDO dental therapist and deductions to the investor; see Equations 5 and 6 of the economic and mathematical model (5)–(13)): 2,600 RUB (labor incentives for medical personnel per one dental service; see the first line of column 21 of Table 3) + 40% (the basic value of the percentage allocated to labor incentives for medical personnel; see the first line of column 14 of Table 3). The same is valid for the remaining lines of column 14 (Table 3).

Column 15 indicates the percentage of income allocated to medical personnel's salary regarding deductions from wages for social insurance (30.2%). According to Section XI, "Insurance Contributions in the Russian Federation" of the RF Tax Code, the tariffs of insurance contributions to the Social Fund of Russia for pensions make 22% of the labor compensation fund (LCF), 5.1% of the LCF is allocated to the Federal Compulsory Medical Insurance Fund, and 2.9% of the LCF is allocated to the Federal Social Insurance Fund, which is a total of 30.0% of the LCF. Federal Law No. 434-FZ of December 22, 2020, "On insurance tariffs for compulsory social insurance against industrial accidents and occupational diseases for 2021 and for the planning period of 2022 and 2023" concerning Resolution No. 713 of the Government of the Russian Federation of December 1, 2005, "On approval of the rules for classifying types of economic activities as professional risk", medical activity refers to the first class of professional risk, which corresponds to a tariff deduction rate of 0.2% of the LCF. Thus, the social insurance contribution rate for dentists is 30.2%.

Column 19 presents the increase in the monthly salary of a dental therapist with a corresponding increase in the actual volume of paid dental services provided, and column 20 shows the monthly salary of a dental therapist with regard to deductions from salary for social insurance (30.2%). Column 21 indicates the labor incentives for medical personnel per one dental service, as determined by the product of the average tariff for a dental service provided by a dental therapist (column 5 of Table 3) and the percentage of income allocated to medical personnel's salary (column 14 of Table 3). Thus, for the first line of column 21 (Table 3), 2,600 RUB = 6,500 RUB (average tariff for a paid dental service; see the first line of column 5 of Table 3) · 40% (percentage of income allocated to labor incentives for medical personnel; see column 14 of Table 3). The same applies to the remaining lines in column 21 of Table 3. Figure 3 presents the labor incentives for medical personnel per dental service, with regard to deductions from salary for social insurance (30.2%).

Column 16 indicates the percentage of income allocated to labor incentives of non-medical personnel of the CDO, and column 17 shows the percentage of income allocated to labor incentives of non-medical personnel regarding deductions from salary for social insurance (30.2%). Figure 4 presents the labor incentives for non-medical personnel in rubles per month, with regard to deductions from wages for social insurance (30.2%). Labor incentives for non-medical CDO personnel amount to 20% of a doctor's monthly income, which in absolute value for the 12th calculation option equals 108,616.69 rubles from one doctor. Since the CDO employs 5 doctors, the funds allocated to labor incentives for non-medical personnel, including administrative and management personnel, are significant and amount to 108,616.69 RUB · 5 = 543,083.45 RUB. It is important to note that in the CDO, part of the income is spent for labor incentives of non-medical personnel, which once again emphasizes the importance of effective motivation of working citizens (dentists, in this article) for management personnel, whose material incentives directly depend on the organized and efficient work of all employees and the CDO in general.

The payment to the lender from one dental service to cover the loan used as investment funds is presented in Figure 5. It is determined by reducing the average tariff for a dental service (see column 5 of Table 3) by its cost (see column 6 of Table 3) and the labor incentives of medical and non-medical personnel per dental service. Thus, for the zero option of simulation, this value makes 435.46 RUB = 6,500 RUB (average tariff for one paid dental service; see the first line of column 5 of Table 3) – 2,164.54 RUB (cost of one paid dental service; see first line of column 6 of Table 3) – 2,600 RUB (labor incentives for medical personnel per service; see the first line of column 21 of Table 3) – 1,300 RUB (labor incentives for non-medical personnel per service. Similar calculations are made for the remaining values given in Figure 5.

Figure 6 shows the total payment to the lender (investor) per month, calculated by multiplying the payment to the creditor from one dental service by the number of dental services provided per month. For example, for the zero option of simulation, this value is 21,881.96 RUB = 435.46 RUB · 50 dental services per month (see first line of column 2 of Table 3). Similar calculations are made for the remaining values given in Figure 6. With an increase in the volume of dental services by half as much, the total deductions to the investor also increase by a factor of 2.74, from RUB 21,881.96 per month up to 59,937.07 RUB per month (see Figure 6).

The debt repayment schedule when using loan funds for the organization and development of a CDO is presented in Tables 4 and 5 [51, 52]. To purchase a universal dental workstation, 5 million rubles are required. The average term of a consumer loan for such purposes is 10 years. According to the official website of the Central Bank of the Russian

Federation, the average market values of the total cost of consumer credits (loans) in percentage per annum [53] as of November 16, 2023 are 22.83% per annum.

Assume that the number of dental therapists working in the CDC is 5. In other words, the CDO is a dental organization with a therapeutic profile. Receipts from all dental therapists per month are determined by multiplying the total payment to the lender (investor) per month (see Figure 6) by 5 (the number of dental therapists). Thus, this value amounts to 109,409.82 RUB (see column 2 of Table 4) = 21,881.96 RUB (total payment to the lender per month, see Figure 6) · 5 (number of dental therapists).

Table 4. Debt repayment schedule when using loan funds for the organization and development of a CDO (one universal dental workstation, a dentist's workplace)

Period (month)	Receipts from all doctors per month for loan repayment, RUB	Monthly payment, RUB	Part payment against debt per month, RUB	Interest payment per month, RUB	Debt balance at the end of the month, RUB
1	2	3	4	5	6
1	109,409.80	106,188.62	11,063.62	95,125.00	4,988,936.38
2	109,409.80	106,188.62	11,274.11	94,914.51	4,977,662.27
3	109,409.80	106,188.62	11,488.60	94,700.02	4,966,173.67
4	109,409.80	106,188.62	11,707.17	94,481.45	4,954,466.51
5	109,409.80	106,188.62	11,929.90	94,258.73	4,942,536.61
			....		
117	109,409.80	106,188.62	98,477.87	7,710.76	306,818.10
118	109,409.80	106,188.62	100,351.41	5,837.21	206,466.69
119	109,409.80	106,188.62	102,260.59	3,928.03	104,206;10
120	109,409.80	106,188.62	104,206.10	1,982.52	0.00
Total		12,742,634.64	5,000,000.00	7,742,634.64	

To calculate the amount of the monthly payment indicated in column 3 (Table 4), the following equation is used [51, 52]:

$$R = P \cdot \frac{r}{100} \cdot \frac{\left(1+\frac{r}{100}\right)^n}{\left(\left(1+\frac{r}{100}\right)^n - 1\right)} \tag{14}$$

where R is the amount of the monthly loan payment; P – loan amount; r – interest rate on the loan per month (%); n – total number of loan payments for the entire loan term (number of months).

To calculate the balance of the principal amount of the loan for any month of the loan term (column 6 of Table 4), the following equation can be used [51, 52]:

$$P_{T+1} = P \cdot \frac{\left(1+\frac{r}{100}\right)^n - \left(1+\frac{r}{100}\right)^T}{\left(\left(1+\frac{r}{100}\right)^n - 1\right)} \tag{15}$$

where T is the number of the settlement period in which the last urgent payment has already been made.

Analysis of the data presented in Table 4 shows that the loan will be repaid on time, and the monthly receipts from all dental therapists to repay the loan cover the monthly loan payment; however, the margin of financial strength in this case is only 3%.

If, with an increase in the volume of dental services by half as much, all funds received from all dental therapists per month to repay the loan are allocated to a monthly loan payment, such a loan will be repaid in 21 months (Table 5).

Noteworthy, the amount of interest payments for the loan in case of advance redemption is 7.22 times: RUB 7,742,634.64 (loan overpayment if it is repaid within 10 years, see the last line of column 5 of Table 4): RUB 1,072,876.28 (loan overpayment if it is repaid early within 21 months, see the last line of column 5 of Table 5) = 7.22 times) less than the loan overpayment if the debt is repaid exactly on time in the amount of monthly payments (compare the last line of column 5 in Tables 4 and 5).

As follows from the calculation results (Table 3), with an increase in the actual volume of paid dental services (column 2) by half as much, the income from the provision of the actual volume of paid dental services to the population (column 7) increases from RUB 3,919,500.00 in the basic modeling option up to RUB 5,879,250.00 (in version 12), i.e., by half as much.

Table 5. Scheme for early debt repayment schedule when using loan funds for the organization and development of a CDO (one universal dental workstation, a dentist's workplace)

Period (month)	Receipts from all doctors per month for loan repayment, RUB	Monthly payment, RUB	Part payment against debt per month, RUB	Interest payment per month, RUB	Debt balance at the end of the month, RUB
1	2	3	4	5	6
1	299,685.35	106,188.62	204,560.35	95,125.00	4,795,439.65
2	299,685.35	106,188.62	208,452.11	91,233.24	4,586,987.54
3	299,685.35	106,188.62	212,417.91	87,267.44	4,374,569.63
4	299,685.35	106,188.62	216,459.16	83,226.19	4,158,110.46
5	299,685.35	106,188.62	220,577.30	79,108.05	3,937,533.17
6	299,685.35	106,188.62	224,773.78	74,911.57	3,712,759.38
7	299,685.35	106,188.62	229,050.10	70,635.25	3,483,709.28
8	299,685.35	106,188.62	233,407.78	66,277.57	3,250,301.50
9	299,685.35	106,188.62	237,848.36	61,836.99	3,012,453.14
10	299,685.35	106,188.62	242,373.43	57,311.92	2,770,079.71
11	299,685.35	106,188.62	246,984.58	52,700.77	2,523,095.12
12	299,685.35	106,188.62	251,683.47	48,001.88	2,271,411.66
13	299,685.35	106,188.62	256,471.74	43,213.61	2,014,939.92
14	299,685.35	106,188.62	261,351.12	38,334.23	1,753,588.80
15	299,685.35	106,188.62	266,323.32	33,362.03	1,487,265.47
16	299,685.35	106,188.62	271,390.12	28,295.23	1,215,875.35
17	299,685.35	106,188.62	276,553.32	23,132.03	939,322.03
18	299,685.35	106,188.62	281,814.75	17,870.60	657,507.28
19	299,685.35	106,188.62	287,176.27	12,509.08	370,331.01
20	299,685.35	106,188.62	292,639.80	7,045.55	77,691.20
21	299,685.35	79,169.28	77,691.20	1,478.08	0.00
Total	6,072,876.28	2,202,941.72	5,000,000.00	1,072,876.28	

A progressive system of material and moral incentives for dental personnel and a mechanism for accumulating CDO funds for the purchase of highly effective medical equipment, dental instruments, modern medicines, and increasing the dentists' qualifications are the most important elements of motivating CDO personnel to increase the actual volume of dental services provided to the population and reduce their unit cost. The essence of the mechanism and tools for progressive remuneration of medical and non-medical personnel of the CDO is that with an increase in the actual volume of paid dental services provided, the percentage of deductions from the income received by the dentists, directed to increasing their salary, increases. The increase in deductions for medical personnel's salary is determined by the financial result of the reduction in the total cost of the actual volume of dental services, which is indicated in column 9 (Table. 3). Thus, in the basic version of the modeling (zero line, Table 3), 40.00% is allocated to the salary of a dental therapist of the CDO (column 14), and with an increase in the actual volume of paid dental services by 17%, 45.90% of the monthly income is allocated to the dentist's salary (line 4); with an increase of 46%, 53.00% (line 11) is allocated to labor incentives for the dental therapist, etc. The amount allocated for a dental therapist's salary also increases proportionally (column 21) from RUB 130,650.00. in the basic version of modeling up to 292,122.06 rubles. (by a factor of 2.24) with an increase in the actual volume of paid dental services by half as much. It is important to note that despite the decrease in the percentage of deductions for CDO development (column 18), the total payment to the lender per month increases. In the basic version of modeling, it is equal to 21,881.96 rubles, and with an increase in the actual volume of paid dental services by half as much, it makes 59,747.74 rubles (see Figure 6), i.e., increases by a factor of 2.74 compared to the basic modeling option.

5. Discussion

1. With an increase in the actual volume of paid dental services by half as much, which is quite achievable and complies with the standard workload of dentists (Equation 3 of the economic and mathematical model), the salary of a CDO dental therapist is equal to 292,122.06 rubles per month and increases compared to the basic modeling option by a factor of 2.24.

This result confirms the previously put forward hypothesis about the positive impact of the innovative business model for CDO development, created by the authors, on the growth of CDO income, an increase in dentists' salaries, deductions

to labor incentives for administrative and managerial personnel, and the total profit of the clinic.

At the same time, this result is in good agreement with other studies by the authors devoted to models for managing medical organizations and social financial technologies for the development of enterprises and the Russian economy, enriching the previously obtained results and complementing them. It should be noted that in the early publications of the authors, the emphasis was placed exclusively on the growth of material and moral incentives for the workforce, leaving outside the scope of the study questions about attracting additional sources of financing for the development of the dental business and the interests of investors and owners of businesses, which was done in this study and makes it possible to supplement the previously created system for managing the financial resources of enterprises with the results of this study.

2. An increase in the actual volume of paid dental services provided to the population, despite a decrease in the percentage of deductions for CDO development from 40.00% to 26.21% (see column 18), leads to an increase in the total payment to the lender (Figure 6). *Thus, these calculations prove that the motivated and effectively organized work of dentists positively influences CDO development and provides the lender (investor) with an increase in total payments by half as much to RUB 59,747.74. This result is achieved by only one dentist.*

This unique result is consistent with and confirms the above proposed hypothesis regarding the attractiveness of the developed business model for investors. Similar results were obtained by the authors in another study devoted to economic and mathematical modeling of the process management of financial flows of an enterprise, which substantiated and proved the feasibility, attractiveness, and economic efficiency of enterprise investment in key customers and categories of food products in their relationship with the progressive system of labor incentives and deductions for enterprise development and increasing material incentives for the management of the enterprise, owners, and investors, using methods of dynamic programming, system analysis, and management. Thus, in this sense, this research serves as a logical continuation of the authors' earlier studies and their expansion to the sphere of providing dental care to the population as the most socially significant and sensitive to changes in market conditions, effective demand, and external and internal turbulence in financial markets.

3. The economic and mathematical model developed in this scientific article, tools, software, and information support, an algorithm for stimulating medical labor and increasing CDO profits available for distribution among owners and investors, contributing to an increase in the actual volume of paid dental services provided to the population, and a mechanism for progressive employee compensation create an essential source of improvement for CDOs.

The second hypothesis about the involvement of the entire workforce in the process of managing a medical organization, realizing their needs for the acquisition of advanced medical equipment and medicines, based on the number of financial resources transferred by each dentist to the CDO development fund (see above) is also confirmed, since the developed innovative business model allows each dentist to be a direct participant in the development of the organization. Table 3 developed using the example of one of the typical CDOs in Moscow is a financial plan and the result of the development of dentists, where they can see the relationship between their individual working results for the reporting period with the funds that they transferred to the development fund and debt repayment in the event of raising funds for the development of their workplaces. This result makes them financially and morally interested in the CDO performance efficacy, reduces the turnover of highly qualified personnel, and increases the prestige and demand for the profession of a dentist.

4. The total income received from all CDO dentists providing paid dental services is equal to RUB 32,585,007 = RUB 6,517,001.40 per year (total income from the provision of paid dental services by a dentist, see the last line, column 12 of Table 3) · 5 (the number of dentists in the CDO), and *the total funds for loan repayment are RUB 299,685.35 per month or RUB 3,596,224.20 per year.*

5. An increase in the volume of paid dental services by half as much to 905 services per year, which corresponds to the standard workload of a dental therapist for one pay rate, considering the throughput of the dentist's workplace (universal dental workstation) of the CDO, makes it possible to:

- Increase income from the provision of paid dental services to the population by a factor of 1.66;

- Increase the dental therapist's salary by a factor of 2.24;

- Increase deductions from only one dentist's salary to labor incentives for non-medical CDO personnel by a factor of 1.66;

- Increase the total profit of the CDO available for distribution among owners and investors by a factor of 1.75 at the expense of only one dentist;

- Ensure timely debt repayment when using loan funds for CDO organization and development;

- Achieve early repayment of the loan in 21 months, provided that all funds received from all dentists per month for CDO development will be used as a monthly loan payment.

A similar significant increase in total income, material labor incentives for dentists, and profits available for distribution among owners and investors is observed for other CDO dentists providing paid dental services to the population.

6. Conclusions

The innovative business model for CDO development created in this research represents a financial plan and the result of a dentist's development. The research simulates the growth of income and profit of the CDO from the provision of paid dental services to the population by a dental therapist due to an increase in the actual volume of the provided paid dental services, a decrease in their unit cost and average prices for paid dental services provided, and, most importantly, an increase in dentists' salaries and CDO profits available for distribution among owners and investors.

This innovative business model allows dentists to participate in CDO management, coordinating with top managers their needs for the purchase of highly effective medical equipment, the purchase of a universal dental workstation (equipping a dentist's workplace), dental instruments, and advanced medicines, depending on the amount of profit from the provision of paid dental services by each CDO dentist. The developed methodology, which includes tools, information support, and software that make it possible to determine the amount of monthly remuneration depending on the LPC of each dentist, ensures the development of the CDO and leads to the fact that not only investors, administrative staff, managers, and owners of the CDO are interested in improving their work and the functioning of the CDO, but also the entire workforce is thinking about their professional growth, improving the quality, occupational prestige, and demand for their work, which contributes to a significant increase in the availability of dental care for Russian citizens. Comparisons with other studies and scientific knowledge increments are presented in Table 1.

This research is a logical continuation of a series of scientific studies aimed at the development and practical implementation of a methodology for mathematical modeling of processes for managing the development of enterprises and organizations of all forms of ownership and the Russian economy as a whole, including progressive methods and instruments for labor incentives for health workers and administrative and managerial personnel, social financial technologies as an instrument for increasing employee wages and developing enterprises and the country's economy as a whole, and sovereign emissions as a source of investment in the development of enterprises (see [13, 26, 29]). At the same time, the key differences between this study and previous scientific research include the combined application of the results of solving the nonlinear programming problem of maximizing dentists' salaries (Equations 5 to 13), the material remuneration of dentists (bonuses) based on the results of work for the reporting period (year, quarter, etc.), determined by Equation 13 of the economic and mathematical model (5)–(13), material labor incentives for non-medical personnel, and deductions for the development of commercial dental clinics, considering the attraction of investor funds and the development of schemes for debt repayment.

Dentists and managers of dental organizations of all forms of ownership that provide paid dental services and investors who are ready to invest financial resources in the creation and development of commercial dental clinics are the main users of the results obtained. The findings obtained using the economic and mathematical model (5)–(13) developed by the authors can be applied to implement an innovative development strategy for a dental organization in investment, marketing, and other related areas of activity.

The developed progressive system for stimulating dentists' labor (Equations 5 and 13) of the economic and mathematical model (5)–(13) is intended for HR departments of commercial dental clinics. Its goal is the practical implementation of a bonus system of remuneration for dentists and non-medical personnel depending on key performance indicators: revenue of the dental clinic, absence of defects in the work of dentists, reduction of the share of dental services provided under warranty, and the dentists' labor participation rate.

6.1. Implications and Explanation of the Results

Analysis of the data presented in Tables 3 and 5 gives reason to believe that it is most effective to allocate all funds received from all dentists per month to repay the loan for CDO development, namely, to purchase a universal dental workstation to expand the CDO capacity for early debt repayment over 21 months, which in the future will allow to significantly increase the volume of dental services in conditions of almost unlimited demand for them from the population, as shown in the article above when analyzing the demand for paid dental care.

6.2. Strengths and Limitations of the Study

An innovative business model developed by the authors, including an economic and mathematical model, an algorithm, and tools for its practical implementation, based on a progressive system of labor incentives for dentists and administrative and managerial personnel, and the practical implementation of a comprehensive business modeling system exemplified by one of the typical commercial dental organizations in Moscow, gives the opportunity to the person making managerial decisions: a) to increase material incentives for dentists depending on the increase in the volume of

sales of paid dental services, regarding the optimal distribution of funds between dentists, administrative and managerial personnel, owners and investors, and the deductions to debt repayment; b) to increase deductions for the CDO development and the profits available for distribution among owners and investors, which makes it possible for the entire team to participate in the CDO management process and allocate funds to its further development and investment in the most promising technologies for providing dental care to the population, the purchase of high-tech and in-demand equipment, equipping the dentists' workplaces, and improving their qualifications.

Model limitations include the following:

1) The financial result from the activities of one dentist does not depend on the activities of other dentists. Loan debt repayments are the sum of the financial results of the activities of all dentists working in the CDO in question for the reporting period, which in practice may not always be implemented;

2) The system under consideration is closed; that is, no additional funding is provided for the entire period;

3) The quality, completeness, and reliability of initial data on the activities of typical commercial dental organizations may limit model performance;

4) Information about the structure, operating and investment activities, and initial data for modeling provided by the top managers of a typical CDO rendering paid dental services is correct; all employees of the typical CDOs under consideration are interested in implementing the innovative business model developed in this research, and the opposition of those who, for some reason, do not want to participate in the progressive system of incentives for labor and CDO development being implemented in the CDO is insignificant for the results of this research. In other words, within the framework of this study, this influence can be neglected;

5) Any hidden factors, i.e., those that do not manifest themselves explicitly, will not significantly affect the quality and results of modeling and the practical implementation of the innovative business model for CDO development created in this study;

6) The standard CDO is active and will continue economic activities in the foreseeable future (within the loan repayment planning horizon);

7) In the future, the responsible attitude of the owners of the dental business, investors, workforce, and other interested parties will remain in the competent management of its daily activities and further development;

8) CDO will comply with all laws, regulations, dental patient care regulations, and standard protocols that apply thereto;

9) The standard CDO will obtain or renew all necessary medical licenses and permits to provide dental care, and dentists will regularly improve their qualifications to confirm compliance of their professional abilities with the requirements of the dental care market and medical practice;

10) All cash flows, including loan repayment, received from the provision of dental care to patients occur during the same period (year) to which the income received and expenses incurred refer.

6.3. Recommendations and Direction for Further Research

The innovative business model for CDO development created by the authors can be used to increase the accuracy, efficiency, and validity of managerial decisions in the interests of the development of dental care in the Russian Federation, the profitability of typical commercial dental clinics, the dentists' salaries, and deductions to the development fund of dental organizations.

The results of the development of scientific and methodological apparatus and the implementation of practical tools under this study make it possible to conclude that the stated purpose of the research has been achieved. The completed research provides managerial decision-makers with effective business modeling tools for developing CDOs that provide paid dental services to the population.

Directions for further research are introducing a progressive system of labor incentives for employees in other areas of activity, for example, the provision of educational services to motivate scientific and pedagogical workers to highly effective work, improving their qualifications and professional level; expanding the technology for setting and solving the problem of business modeling for promising investors and searching for optimal sources of financial resources from the viewpoint of the weighted average price for the implementation of investment in dental care; developing and implementing promising digital technologies for the provision of dental care; adapting the economic and mathematical model developed in this research at enterprises in all sectors of the economy; including the developed economic and mathematical tools into a unified information and analytical system by dental medical organizations, their interaction with widely used applied software products, and others.

7. Declarations

7.1. Author Contributions

Conceptualization, E.V.K.; methodology, E.V.K.; software, E.V.K.; validation, E.V.K. and G.G.B.; formal analysis, G.G.B.; investigation, E.V.K. and G.G.B.; resources, G.G.B.; data curation, G.G.B.; writing—original draft preparation, E.V.K. and G.G.B.; writing—review and editing, E.V.K.; visualization, G.G.B.; supervision, E.V.K.; project administration, E.V.K. and G.G.B.; funding acquisition, G.G.B. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data presented in this study are available in the article.

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The authors received no financial support for the research, authorship, and/or publication of this article.

7.4. Institutional Review Board Statement

Not applicable.

7.5. Informed Consent Statement

Not applicable.

7.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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