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Digital Transformation of Socio-economic Development by The Quality-of-Life Vision

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Abstract: In this study, we investigate the digital transformation of socio-economic development through the quality-of-life vision, highlighting the importance of sustainable and inclusive strategies that prioritize the well-being of individuals and communities. Digital technologies have transformed socio-economic development worldwide. Assessing the quality of life in the digital economy is essential to ensure that everyone benefits from this transformation. Artificial intelligence (AI) and big data can help policymakers make informed decisions to achieve this goal. Technological singularity is the hypothetical point at which AI surpasses human intelligence. This could have profound social and economic consequences. New indicators, such as digital service availability, are emerging to measure quality of life in the digital economy. AI methods can be used to analyze this data and make decisions that improve society's well-being. High-performance computing (HPC) and big data technologies can be used to collect real-time socio-economic statistics. The feedback mechanism in Web 4.0 and the transfer of economic processes to online platforms provide the necessary data for analysis. This paper does not provide specific results, but it highlights the potential of HPC, big data, and AI to assess quality of life in the digital economy. This data can be used to make informed decisions that positively impact society. Digital technologies have created new challenges in assessing quality of life. However, it also presents an opportunity to use HPC, big data, and AI to make informed decisions that benefit everyone.

Keywords: Digital Economy, Quality of Life, Artificial Intelligence, Digital Environment.

1 Introduction

The authors consider the problem of predicting the activities of a government or another institution of power, whose task is the optimal distribution of the limited funds of the country's budget [1]. The criterion is an integral life quality indicator reflecting the primary indicators of the World Health Organization and the United Nations [2-3]. In this paper, an additive criterion is proposed containing weighting coefficients reduced to a single equivalent, reflecting the difference in territories in terms of natural conditions and the level of development [4]. Such an approach formalizes the problem as a mathematical model [5]. The basis is a set of initial and target indicators included in the integral life quality indicator [6]. Limitations are the possibilities of spending the budget invested in various social and economic institutions [7-8]. Digital technologies have significantly changed society's social and economic development [8].

The concept of technological singularity, where machines surpass human intelligence, has led to new ways of assessing the quality of life in the digital economy [9]. The availability of online services and the use of artificial intelligence methods to make decisions that affect society for an extended period have created new indicators for measuring the quality of life. High-Performance Computing (HPC) and Big Data technologies provide the necessary resources for real-time data collection on socio-economic statistics, which can be analyzed using artificial intelligence methods to make informed decisions [10]. However, applying these technologies in the digital economy raises new challenges and opportunities that require careful consideration. This article explores the digital transformation of socio-economic development through the quality-of-life vision. It highlights the need for sustainable and inclusive digital transformation strategies that prioritize the quality of life of individuals and communities.

2 Literature Review

Economic and statistical data on the impact of investments in social, state, and other spheres of economic activity are analyzed at the machine learning level [11]. The methods of statistical analysis determine the dependence of fundamental indicators on investments. It is formalized in functions that depend on time, as the second argument [12].

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The allocation of funds in each social or economic sphere manifests itself after particular, reasonably long periods [13-14]. The problem's solution uses the theory of optimal processes using dynamic programming, the Bellman principle, and the idea of stochastic processes. In implementing plans to improve the quality of life, the requirement of constant growth for each of them is not imposed [15-16].

The primary condition is within acceptable limits, with the criterion's maximum reached [17]. Thus, an algorithmic basis creates software-based expert systems tools for supporting governmental decisions for a long investment planning horizon. An important feature is optimizing spending limited resources according to the maximum integral life quality indicator [18]. It is the form of abstract mathematical formalisms that makes it possible to connect such concepts as digitalization, socio-economic statistics, life quality criteria, and, most importantly, to find a scientifically based approach to academic support of decision-making at the highest level within the framework of quality improvement problems across regions and countries [19].

The digital economy is transforming various aspects of society, including organizational capabilities, circular economy, government, and economics. Konopik et al. [1] proposed a conceptual framework for mastering digital transformation through organizational capabilities. García-Muiña et al. [2] developed an Industry 4.0-based dynamic Social Organizational Life Cycle Assessment to target the social circular economy in manufacturing.

Plociennik et al. [3] introduced a Digital Lifecycle Passport for the Circular Economy. The role of government in the digital economy Pan et al. [11] explored the digital economy as an innovation driver for total factor productivity.

Lorentzen [12] examined digital transformation as distributed leadership. Rădulescu et al. [13] presented a multi-criterion weighting approach for Quality-of-Life evaluation. Ma and Zhu [14] investigated innovation in emerging economies driven by the digital economy. Purnomo et al. [15] conducted a retrospective review of digital economy research over the past 35 years. Yin et al. [16] argued for integrating ecosystem services into socio-economic development to enhance the achievement of sustainable development goals. Ko et al. [17] explored non-market strategies and building digital trust in sharing economy platforms. Ma et al. [18] evaluated the role of the digital economy in natural resources tax volatility and economic performance. Todorov [19] evaluated project and program management as a factor for socio-economic development within the EU.

Waschull et al. [20] investigated the redesign of blue- and white-collar work triggered by digitalization. Williams [21] discussed the digital economy and Industry 4.0 concepts in intelligent and information systems. Wang et al. [21] examined managing privacy in the digital economy. Bril et al. [23] explored personnel changes and labour productivity in regulatory budget monitoring.

Kraus et al. [24] provided an overview of the current status quo of digital transformation in business and management research. Milenkovic et al. [25] employed a multivariate approach to measuring socio-economic development in MENA countries. Arribas et al. [26] investigated the inclusion of socially irresponsible companies in sustainable stock indices. Kaklauskas et al. [27] conducted a quality of city life multiple criteria analysis.

Menzefricke et al. [28] identified and analyzed existing socio-technical risk management approaches in the digital transformation age. Barykin et al. [29] discussed the economics of digital ecosystems. Duygan et al. [30] explored innovative city development's spatial and socio-economic configurations. Kraus et al. [31] analyzed the current research on digital transformation in healthcare.

Ma et al. [32] proposed a route to improve the effectiveness of negative PSAs. Barrutia and Echevarria [33] investigated the effect of the COVID-19 pandemic on public managers' attitudes toward digital transformation. Kurochkina et al. [34] discussed digital totalitarianism, from Homo sapiens to "one-button man." Daniali et al. [35] predicted the volatility index according to technical index and economic indicators based on the deep learning algorithm. Mostafa et al. [36] used a computational intelligence approach to capture the implied volatility. Chen et al. [37] proposed a sustainability-oriented enhanced indexation model with regime switching and cardinality constraints.

Overall, the literature suggests that the digital economy is a critical driver of socio-economic development. From the authors' point of view, the following works may be closer to the topic of digital transformation of socio-economic development by the quality-of-life vision:

The following opinions from the sources could be interesting for exploring the digital transformation of socio-economic development from the quality-of-life perspective. Social Organizational Life Cycle Assessment (SOLCA) introduced by García-Muiña et al. [2] could be a valuable tool for evaluating the impact of digital transformation on social and environmental factors. Digital Lifecycle Passport for the Circular Economy, suggested by Plociennik et al. [3], could provide a standardized approach for tracking and sharing data on the lifecycle of products and services, contributing to sustainable development goals.

A multi-criterion weighting approach by Rădulescu et al. [13] for Quality-of-Life evaluation could be a valuable tool for assessing the impact of digital transformation on the quality of life of individuals and communities. A critical aspect of the digital transformation of socio-economic development emphasized by Yin et al. [16] considers the importance of integrating ecosystem services into socio-economic development to enhance the achievement of sustainable development goals in the post-pandemic era. Kraus et al. [24] provide an overview of the current status quo of digital transformation in business and management research, which could provide valuable insights into the latest trends and best practices in digital transformation for socio-economic development. Kaklauskas et al. [27] propose a Quality of City Life multiple criteria analysis, which could be a valuable tool for assessing the impact of digital transformation on the quality of life of individuals living in cities. Barykin et al. [29] propose an Economics of Digital Ecosystems, which could provide insights into the economic impact of digital transformation on different sectors of society.

Overall, these sources provide exciting perspectives on the digital transformation of socio-economic development from the quality-of-life vision, and their opinions could contribute to a more comprehensive understanding of the topic. The authors consider the problem of the optimal distribution of limited funds for the digital transformation of socio-economic development aiming to improve the quality of life.

3 Methodology

The theory of optimal processes is applied to calculate an investment plan for each period, such that the resulting distribution of funds maximizes the improvement in quality of life, subject to the constraint that the sum of the weighted indicators equals a particular value. This algorithm can be embedded into software solutions for various tasks, particularly allocating budget components for social tasks.

The data of the Ministry of Health (https://minzdrav.gov.ru/) and the Ministry of Labor and Social Protection (https://mintrud.gov.ru/) are taken as the basis of the algorithm proposed in the work.

In the context of the digital transformation of socio-economic development by the quality-of-life vision, investments can be made in various areas to improve the well-being of individuals and communities. Using data from the Ministry of Health and the Ministry of Labor and Social Protection, some areas of investment that could be prioritized include:

Healthcare infrastructure: Investments in healthcare infrastructure can improve access to healthcare services and facilities, especially in rural and remote areas. This can include building and upgrading hospitals, clinics, and healthcare centres and investing in medical equipment and technology.

Digital healthcare: Investments in digital healthcare can improve the efficiency and effectiveness of healthcare delivery and patient outcomes. This can include investments in telemedicine, electronic health records, and remote patient monitoring.

Education and training: Investments in education and training can help build a skilled workforce equipped to meet the digital economy's demands. This can include investments in vocational training programs and incentives for students to pursue careers in technology and healthcare.

Social protection: Investments in social protection programs can help to reduce poverty and inequality and improve the quality of life for individuals and communities. This can include investments in social welfare programs, such as unemployment benefits and pensions, as well as programs that promote social inclusion and community development.

Research and development: Investments in research and development can help drive innovation and growth in the digital economy and improve our understanding of socio-economic issues. This can include academic research investments and public-private partnerships promoting innovation and technology transfer.

Overall, investments in these areas can promote the digital transformation of socio-economic development through the quality-of-life vision while addressing individuals' and communities' specific needs and priorities. By investing in these areas, policymakers can help build a more equitable and sustainable society where everyone can thrive. The calculation based on the methodology for determining the order of the direction of investments and their volume makes it possible to form an algorithm designed for the digital platform within the framework of the "electronic government" project (https://digital.gov.ru/). The authors consider two primary components of the framework of the research.

Firstly, the framework refers to a methodology for determining the order of the direction of investments and their volume. This methodology likely involves analyzing economic and statistical data to determine the impact of investments in different sectors and areas of socio-economic development. This analysis would then be used to determine the optimal direction and volume of investments to maximize the impact on the quality of life of individuals and communities.

Secondly, this methodology can be used to form an algorithm designed for the digital platform within the framework of the "electronic government" project. The "electronic government" project is a government initiative in Russia aimed at digitizing government services and improving their accessibility to citizens through online platforms. The algorithm in the statement would likely be designed to automate the investment process based on the methodology described above. This would allow for more efficient and effective decision-making and greater transparency and accountability in the investment process.

Overall, the researchers use this methodology to determine the direction and volume of investments in socio-economic development that can be used to inform an algorithm designed for a digital platform within the "electronic government" project. By leveraging data and technology, policymakers can improve the quality of life for individuals and communities while promoting greater efficiency and transparency in government decision-making.

The authors' approach using a mathematical model considers two main directions of investment in the healthcare segment.

1. In the equipment of medical and preventive institutions

2. In the training and education of specialists.

Authors' data analytics consider it possible to approximate the following dependencies:

Investing funds q in the first areas under consideration allows you to get an effect in dependence $F(q)$ while reducing the number of funds to the value $\varphi(q)$. It is also determined that investments r in the second direction give an effect $G(r)$ with a further decrease in the amount to the value $\vartheta(r)$.

We also denote the length of the planning horizon for investment activities in the healthcare segment by the number of periods, which will allow, if necessary, either to adjust this funding or redirect funds to other government programs.

In planning periods i (where $i = 1,...,m$) denote q_{i-1}, r_{i-1} the funds invested at the end of the $(i-1)$-th planning period for the next. Let us introduce the amount of financing of the sector under consideration P_0 as the total planned within the budget framework.

Then, for each planning period, the equality is true:

$$P_{i-1} = q_{i-1} + r_{i-1}$$

Furthermore, the search for a solution is reduced to determining the maximum function $Z_i^*(P_{i-1})$ for the entire series $i = 1,...,m$.

The authors could show the algorithm in Figure 1.

At the final planned interval, according to the Bellman principle, the following should be performed:

$$Z_m^*(P_{m-1}) = \max_{0 \le q_m \le P_{m-1}} \left\{ Z_m\left(P_{m-1}, q_m\right) \right\}.$$

Based on the available data, we rewrite this ratio in the following form:

$$Z_m^*(P_{m-1}) = \max_{0 \le q_m \le P_{m-1}} \left\{ F(q_m) + G(P_{m-1} - q_m) \right\}$$

At the next stage of the calculation, the expression can be rewritten considering the impact of reducing the investment amount. Thus, we calculate the following ratio:

$$Z_{m-1}^*(P_{m-2}, q_{m-1}) = \max_{0 \le q_{m-1} \le P_{m-2}} \left\{ F(q_m) + G(P_{m-1} - q_m) + Z_m^*\left[\varphi(q_{m-1}) + \vartheta(P_{m-1} - q_{m-1})\right] \right\}$$

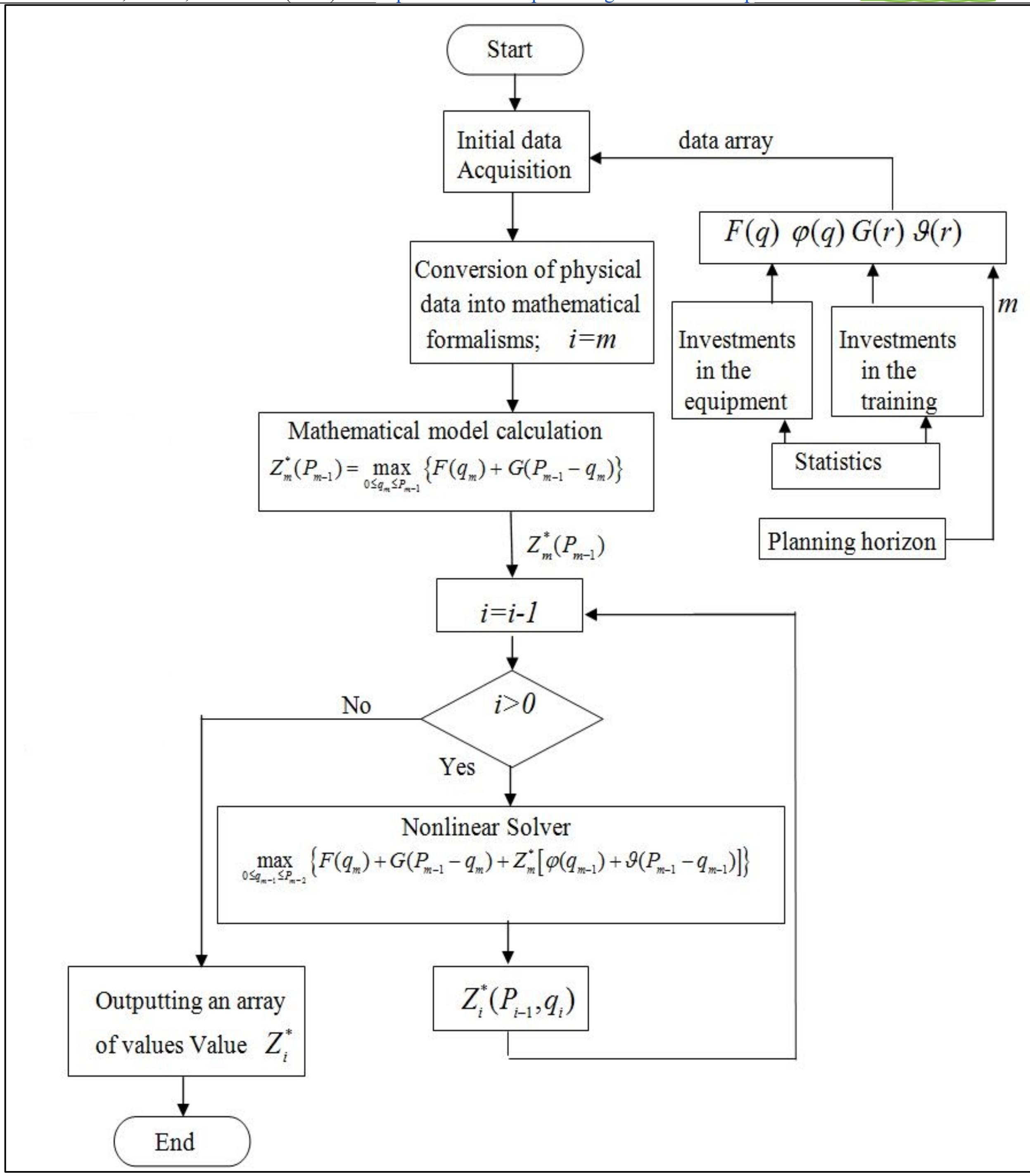

Fig. 1: The authors' algorithm for the developed model

After determining the desired dependencies $Z^*_m(P_{m-1})$, $Z^*_{m-1}(P_{m-2}, q_{m-1})$ further calculation, starting from $i = m-2$, will be carried out using the recursive formula:

$$Z^*_i(P_{i-1}, q_i) = \max_{0 \le q_i \le P_{i-1}} \left\{ F(q_i) + G(P_{i-1} - q_i) + Z^*_{i+1}\left[\varphi(q_i) + \vartheta(P_{i-1} - q_i)\right] \right\}.$$

We carry out calculations up to the initial period of investment planning and obtain an expression for determining the first value:

$$Z_i^*(P_0) = \max_{0 \le q_1 \le P_0} \left\{ F(q_1) + G(P_0 - q_1) + Z_2^*\left[\varphi(q_1) + \vartheta(P_0 - q_1)\right] \right\}$$

The calculation results for $m=5$ approximating power functions $F(q)\,G(r)$ are given in Figure 2.

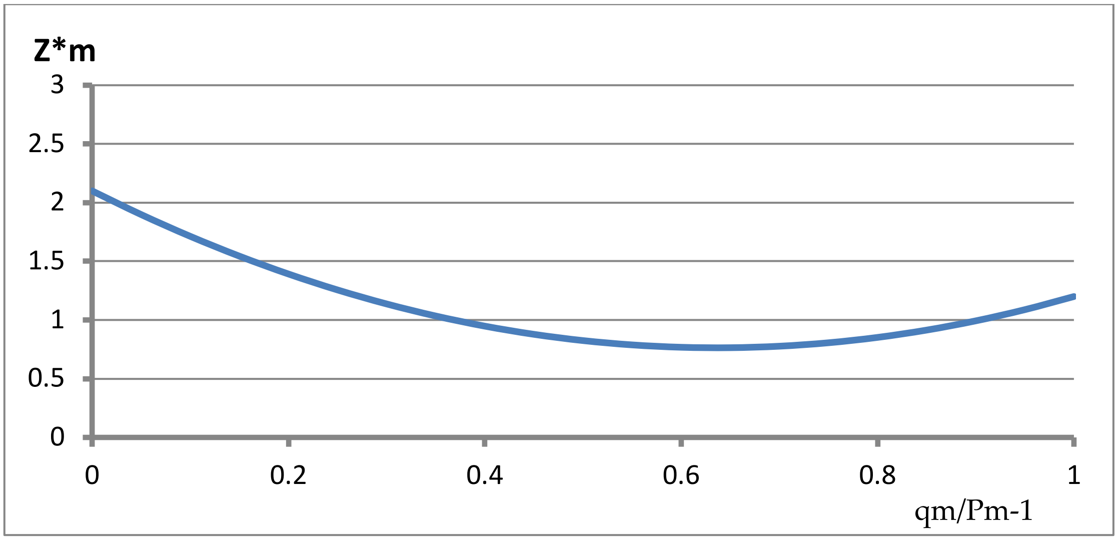

Fig. 2: The calculation results of the developed model for $m=5$

4 Results and Discussion

In the context of digital transformation in socio-economic development, the criterion for measuring the quality of life is regulated within a certain period using a calculation method that involves a set of indicators summarized in a vector. Each indicator is assigned a set of weighting coefficients represented by a vector of the same dimension. Machine learning algorithms are employed to analyze economic and statistical data on the impact of investments in social, state, and other areas of economic activity and to determine the nature of the dependence of each indicator on investment. These dependencies are then formalized into a set of functions.

The presented research findings provide insights into developing models for analyzing the impact of digital technologies on the quality of life and calculating the optimal investments directed by the government in the healthcare segment. Investments in medicine and the building of new hospitals, in addition to increasing indicators reflecting the category of health in terms of the quality of life, also profit from the sale of paid services and reduce losses for disability pay. The same is valid for cultural facilities, sports facilities, the creation of communication, television broadcasting networks, the improvement of road infrastructure, etc.

The authors have developed an idea which explores the impact of technological singularity on the economic, social, and environmental factors that influence the quality of life in China. Using machine learning, the study [32] analyses statistical data on the effects of investments in various areas of economic activity, including social services.

The developed mathematical model is constructed using the maximum principle and gives the solution as a set of recurrent formulas. By continuing the calculation in the same way for each period, control for an arbitrary state of the system is obtained.

Finally, the authors obtain solutions where the general quality criterion is maximized. Exploring the digital transformation of socio-economic development through the quality-of-life vision has highlighted the potential of High-Performance Computing (HPC) and Big Data technologies to provide real-time data collection and analysis on socio-economic statistics. Applying artificial intelligence methods to this data can lead to more informed decision-making, enabling policymakers to design sustainable and inclusive strategies that prioritize the well-being of individuals and communities.

Overall, this study highlights the potential of digital transformation in socio-economic development through the quality-of-life vision while also emphasizing the importance of sustainable and inclusive strategies that prioritize the well-being of individuals and communities. By carefully considering these challenges and opportunities, policymakers can design effective and equitable policies that promote the well-being of all members of society.

4.1 Discussion and limitations of the model

The authors propose to discuss the algorithm for searching for the optimum integral life quality criterion, which makes it possible to formalize the problem in mathematical terms. The authors could also explore the potential challenges and limitations of the proposed approach and discuss how it can be modified or improved to address these challenges. They could further discuss the role of government and other stakeholders in implementing this approach and ensuring that the maximum integral life quality indicator is achieved.

The authors proposed an approach for implementing software products in the form of institutional decision-making support systems for a long horizon of planning investments in the quality of life. The researchers consider the form of mathematical abstract formalisms that make it possible to connect such concepts as digitalization, socio-economic statistics, life quality criteria, and, most importantly, to find a scientifically based approach to intellectual support of decision-making at the highest level within the framework of quality improvement problems across regions and countries. In the socio-economic system, the life quality criterion is regulated, and the calculation method is set for a specific, sufficiently long period, divided into planned time intervals. The result is an algorithm acceptable for embedding in software solutions for a wide range of tasks, primarily related to forming budget components that are directly allocated to social tasks and affect life quality. In this case, finding the indicators within acceptable limits is the fundamental limitation. Modern computing add-ons as part of application software packages allow for reducing all the computational complexity inherent in dynamic programming algorithms to a set of sequential calculations using the given expressions.

The findings of this study suggest that the digital transformation of socio-economic development can significantly impact the quality of life of individuals and communities. By leveraging HPC and Big Data technologies, policymakers can collect and analyze data in real-time, allowing for more accurate and timely decision-making. Furthermore, artificial intelligence methods can provide insights into complex socio-economic issues, allowing for more effective and efficient policy interventions.

The researchers could suggest a discussion on how the proposed approach for the digital transformation of socio-economic development can be applied to improve the quality of life for individuals and communities. They could further discuss how the allocation of funds in each social or economic sphere can manifest itself after particular, reasonably long periods and how this can be accounted for in the planning process.

Moreover, as discussed in the literature review, the authors could compare and contrast their approach with other existing approaches to the digital transformation of socio-economic development. This comparison could provide insights into the strengths and weaknesses of different approaches and help identify areas for further improvement. Overall, the core problem of digital transformation of socio-economic development by the quality-of-life vision regarding the developed approach is to ensure that the proposed investment plan effectively maximizes the quality of life while accounting for the limited resources available for investment.

5 Conclusions

The challenge is to develop a comprehensive set of indicators that can accurately measure the quality of life and determine the appropriate weighting coefficients for each indicator. Another challenge is determining the appropriate time intervals for measuring the impact of investments and implementing allocation changes. Regarding the developed approach, the core problem of digital transformation of socio-economic development by the quality-of-life vision is how to allocate limited resources to maximize the improvement in quality of life. The approach proposes a method for calculating an investment plan for each period using the theory of optimal processes and dynamic programming, which considers the impact of investments in social, state, and other spheres of economic activity. The goal of the approach is to optimize spending on limited resources such that the resulting distribution of funds satisfies the maximum life quality improvement criterion. However, applying these technologies in the digital economy also presents new challenges that must be carefully considered. Ensuring these technologies are accessible and inclusive to all individuals and communities is a crucial challenge. The ethical and privacy implications of collecting and analyzing large amounts of data must also be carefully considered.

Moreover, the authors could suggest that their approach applies to a wide range of tasks related to forming budget components that are directly allocated to social tasks and affect the quality-of-life level. The proposed algorithmic basis for creating software-based tools of expert systems for supporting governmental decisions must also be thoroughly tested and validated to ensure that it produces accurate and reliable results. Finally, the authors could discuss the potential implications of their approach for policymaking and decision-making at the highest level. They could explore how the proposed algorithmic basis for creating software-based tools of expert systems can support governmental decisions for long-term investment planning and improve the allocation of budget components for social tasks.

Conflicts of Interest Statement:

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria, educational grants; participation in speakers' bureaus, membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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