Saint Petersburg 2022

volume 1 issue 1

An international journal

TECHNO ECONOMICS

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An international journal

PUBLISHER
Peter the Great St. Petersburg Polytechnic University
Corresponding address: 29 Polytechnicheskaya st.,
Saint-Petersburg, 195251, Russia

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Saint Petersburg
2022

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EDITORIAL

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The new world of the 21st century: the double transition

This periodical is being launched in an important transitional era. As in other great historical moments of our civilization, we still have deep geopolitical divergences and disputes of hegemonic nature. But, at earlier times throughout recorded history, these divergences and disputes were based on an essentially analogical and palpable world, as well as heavily dependent on natural resources extracted from the ground (firewood, peat) or subsoil (coal, oil, gas – fossil fuels). Now we have a very different reality, which we are still experiencing as a moment of profound change and transition, towards a digital, virtual world, apparently dematerialized, and fed by new forms of energy support, whose goal is not to harm the already fragile ecological balance of our planet.

Information is becoming the most important commodity of this historical moment, and there seems to be a consensus among humans that we are heading towards a world of non-palpable goods, in which all the necessary information is available in a parallel universe, the cloud, something apparently not tangible. But people forget, or do not realize, that this information is not in any dematerialized world – on the contrary, it is stored in thousands of immense computers around the world, produced with many rare and difficult to obtain materials, and also consuming immense amounts of energy.

Conservation, recycling, saving, efficiency – or better, sustainability – has become an obsession of current times. There is currently a growing realization that human activities are having a major impact on Earth's ecosphere, in such a way that scientists are now defining a new geological era, the *Anthropocene*, a term bothered from the ancient Greek *Anthropos*, meaning human, and -*cene*, meaning recent. There is some discussion about its starting date, ranging from the onset of the Agricultural Revolution (about 12,000 years ago) to as recently as the 1970s. Some prefer to consider as the starting date the beginning of the Industrial Revolution, by the end of the 18th century. This new epoch refers to a time when humans have become the main driving force in the planet's physical changes, and whatever the starting date, there is currently a broad consensus that we now have unprecedented strain on the Earth's natural resources and environment.

This new global consciousness has taken shape in the last quarter of the past century, a new *Weltanschauung*, the entrenching of a new paradigm, the Efficiency Paradigm as advanced by Devezas et al. (2008)[1], through which a huge set of new habits were developed regarding the usage of materials and energy, which led to the development of much more efficient industrial processes, as well as the production of far more efficient automobiles, airplanes, household appliances, buildings, etc.

It is a fact that nations spent a huge amount of capital subsidizing solar and wind energy (as well as other sources) but the share of energy from fossil fuels is nearly unchanged over the last ten years, surpassing the 80% mark. The natural question that follows is why this slow progress in renewable energy sources, which could be desperate for environmentalists most eager for more immediate solutions to avoid the complete collapse of our ecosphere.

It is now of paramount importance to investigate some question marks related to the target of keeping the global average temperature 'well below' 2°C (ideally 1.5°C) established in the Paris Agreement (2015) and reinforced recently in COP 26 in Glasgow (Scotland):

1 – why the slow path observed in the last decade in reducing the usage of fossil fuels?

2 – are the renewable energies sources currently in play indeed the most viable for the expected zero-emissions target to be reached up to 2050? Are they sufficient to cover all global energy necessities for the production and transportation systems?

3 – some of the renewable energy sources currently in intensive development require a high demand for some rare materials, some of them are also highly polluting to extract/produce, rising then the question: where should the materials for the green transition come from?

Undoubtedly, we are living on a new era under a double transition – the Green Transition (the search for alternative and renewable energy sources) and the Digital Transition (the brave new world of Information and Communication new technologies). New energy generating systems are currently an important focus of technological and scientific research. In the same vein, economic studies are also of paramount important to investigate the implications of the new digital reality in our production and commercial systems. No less important are the investigations in the field of management sciences, in order to guarantee the sustainability of this whole new digital reality based on renewable energies.

Considering this moment of double transition, in which a multidisciplinary approach is needed to successfully pave the way for the future, the new journal ***Technoeconomics*** aims to promote the convergence of three investigation fields – technology, economy, and managerial sciences – publishing articles of broad theoretical and applied nature, investigating the impact of various types of technologies (IC, energy, and managerial technologies) on the dynamics of micro- and macro-economic systems. The journal particularly welcomes papers that use econometric and mathematical methods on the above topics and cover such fields, as Technological Evolution, Evolutionary economics, Innovation Process, Technological Forecasting, Digital Transformation.

An important goal of ***Technoeconomics*** is to stimulate communication between researchers who are actively involved in the study of various aspects of the relationship between technological change and economic dynamics.

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Technoeconomics. 2022, Vol. 1, No. 1. Pp. 7–23.
Техноэкономика. 2022, Том 1, № 1. С. 7–23.

Scientific article
UDC 330.34
DOI: https://doi.org/10.57809/2022.1.1.1

BASIC INCOME AS A TOOL TO SUPPORT AGGREGATE DEMAND

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Abstract. The developed economies of the world are now facing new challenges, the main of which are: the degree of human participation in the production process, in which it will not be an "appendage" of new intelligent systems; prevention of further social and economic polarization of society; development of new economic tools to mitigate the negative effects of extensive digitalization of production and services. This paper shows that conditional basic income as a macroeconomic policy tool can be a response to these challenges, especially given its role as the instrument of maintaining aggregate solvent demand.

Keywords: technological change, universal basic income, aggregate demand, economic policy

Funding: The paper was prepared as part of the RFBR grant No. 20-010-00279 "An integrated system for assessing and forecasting the labor market at the stage of transition to a digital economy in developed and developing countries."

Citation: Akaev A.A., Petryakov A.A., Baizakov N., Zeman Z. Basic income as a tool to support aggregate demand. Technoeconomics. 2022. 1 (1). 7–23. DOI: https://doi.org/10.57809/2022.1.1.1

Научная статья
УДК 330.34
DOI: https://doi.org/10.57809/2022.1.1.1

БАЗОВЫЙ ДОХОД КАК ИНСТРУМЕНТ ПОДДЕРЖКИ СОВОКУПНОГО СПРОСА

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Аннотация. Развитые экономики мира стоят сегодня перед новыми вызовами, основными из которых являются: степень участия человека в производственном процессе, при котором он не будет "придатком" новых интеллектуальных систем; предотвращение дальнейшей социальной и экономической поляризации общества; разработка новых экономических инструментов, смягчающих негативные последствия широкой цифровизации сферы производства и услуг. В работе показано, что обусловленный базовый доход как инструмент макроэкономической политики, может быть ответом на эти вызовы, особенно учитывая его роль как средства поддержания совокупного платежеспособного спроса.

Ключевые слова: технологические изменения, безусловный базовый доход, совокупный спрос, экономическая политика

Финансирование: Статья подготовлена в рамках гранта РФФИ № 20-010-00279 «Интегрированная система оценки и прогнозирования рынка труда на этапе перехода к цифровой экономике в развитых и развивающихся странах».

Для цитирования: Акаев А.А., Петряков А.А., Байзаков Н., Земан З. Базовый доход как инструмент поддержки совокупного спроса // Техноэкономика. 2022. Т. 1, № 1. С. 7–23. DOI: https://doi.org/10.57809/2022.1.1.1

Introduction

Industrial growth over the past 100 years has had a tremendous impact on the development of technological infrastructure and changing lifestyles. Three major components of this development are related to personalization: automobile as a personal means of transport and greater personal freedom; personal computer as a means of intellectual autonomy; and personal telephone as a means of freedom of communication and access to information. These three development factors have significantly changed the psychology of the employee and created the conditions for the diffusion of qualitatively new, synthesized (cyber – physical) technologies, which became the basis of Industry 4.0 and the Internet of Things – the two main working concepts of industrial and infrastructure development for the next 20 years. The personalization of consumption and individualization of social demands can be seen as a transition point to a new machine age, which includes: a) Industry 4.0; b) the Internet of Things; c) systems based on elements of artificial intelligence.

These qualitative changes have matured over the past 25–30 years. A key feature of world development during this period was a decline in the rate of economic growth in industrialized countries with simultaneous socio-economic polarization. Another important feature was the qualitatively new role of information and communication technology, which became the basis of the new digital infrastructure of society. As for changes in the nature of labor, they are characterized by three main trends: a) direct replacement of human functions through robotization and computerization; b) rapid washout of certain types of professions due to global information and social networks; c) growth of a parallel labor market (non-standard forms of employment). In essence, the society is facing new challenges, the main ones being: the degree of human participation in the production process, in which it will not be an "appendage" of new intelligent systems; prevention of further social and economic polarization of society; development of new economic tools to mitigate the negative effects of extensive digitalization of production and services. It seems to us that conditional basic income, as a macroeconomic policy instrument, can be an answer to these challenges, especially given its role as an instrument of maintaining aggregate effective demand.

Materials and Methods

Technological factors of the labor changing nature and market

The twentieth century saw a number of empirical patterns accompanying the process of long-term economic growth, when the effects of various economic and financial shocks and crises are smoothed out. A number of them were first formulated by N. Kaldor (Kaldor, 1961). A number of papers published in recent years on the central question of economics – the distribution of income among factors of production and distribution of income and wealth among people – show that not all patterns are observed given the dynamic and widespread use of artificial intelligence (AI) (Korinek and Stiglitz, 2018, 2017; Stiglitz, 2015).

One reason for such rethinking was the rapid growth of the NBIC-technology sector (Bainbridge et al., 2006; Roco, 2011). The technologies of the 4th Industrial Revolution (Schwab, 2016; Schwab and Davis, 2018) and Industry 4.0 itself (Kagermann et al., 2013) have become a practical reality. At the same time, the Industrial Internet is becoming the underlying infrastructure of Industry 4.0 (Greengard, 2021), a digital platform that ensures the efficient interaction of all industrial production facilities based on the Internet. With the emergence of intelligent robots capable of interacting with humans and learning through practical operation, a critical stage in the development of robotics begins, when its mass application in most areas of public life and the economy will take place (Ford, 2015). At the same time, a Blockchain multifunctional digital information technology emerged for the reliable accounting of assets and transactions with them (Swan, 2015).

Applied to present day, much of the negative expectations for the labor market are attributed to the development of digital technology, with estimates from the effects of widespread automation estimated at a reduction of between 9% of the workforce in the European economy (Arntz et al., 2016) and 47% in the US economy (Frey and Osborne, 2017). Much of the urgency of the debate also stems from growing income inequality in advanced economies over the past 30 years (Piketty, 2014; Stiglitz, 2012) and the long-term trend of falling shares of employment in manufacturing in advanced economies (Keese et al., 2017).

McKinsey Global Institute experts' forecast shows that by 2055 half of the existing jobs in all countries of the world could be eliminated due to complete automation of production. Robots could put 1.1 billion workers worldwide out of work and deprive them of $15.8 trillion in wages. As a result of such job cuts, global labor productivity will rise steadily, increasing by 0.8 to 1.4 percent per year.

One of the consequences of the widespread use of digital technology is the decline in average wages, which is due to the widespread use of information and communication technologies, and as a result, their gradual cheapening. Acemoglu and Resrepo (Acemoglu and Restrepo, 2020) note that the use of industrial robots between 1990 and 2007 in local U.S. labor markets has shown that robots can reduce employment and wages: one robot per thousand workers reduces the employment-to-population ratio by about 0.18–0.34 percentage points and wages by 0.25–0.5 percent. According to other estimates of robot use in EU countries, one robot per thousand employees reduces employment by 0.16–0.20 percentage points, i.e., the crowding out effect dominates (Chiacchio et al., 2018). The use of industrial robots across the global economy (Carbonero et al., 2020), also poses significant threats: estimates indicate a long-term employment decline of about 1.3% due to a 24% increase in the number of robots between 2005 and 2014. In developed countries, this reduction in employment is just over 0.5%, while in emerging economies it reaches nearly 14%. The impact of automation on labor market transformation, according to some experts, is long-term and will lead to a significant decrease in labor force participation and an increase in inequality in the long run: automation is very good for economic growth and very bad for equality (Zanna et al., n.d.). There are already attempts to assess the global effects of the widespread use of computers and digital technology on employment. According to a survey by the World Economic Forum (*The Future of Jobs*, 2016), there will be net job losses of 5.1 million jobs between 2015 and 2020 (total job losses will be 7.1 million and new jobs will not exceed 2 million).

In contrast to the views outlined above, there is another point of view which is based on the fact that new technologies in real economic systems do not threaten the employment system, because by displacing some activities, they simultaneously promote the emergence of others. For example, analyzing the U.S. labor market from 1850 to 2015, the authors of the study argue that levels of professional outflow in the U.S. are now at historic lows, and that no more than 10 percent of jobs in the U.S. economy are truly threatened by automation (Atkinson and Wu, 2017). In many cases, machines replace and complement human labor; they add value to those tasks that are accomplished through the unique qualities of workers (Autor, 2015). Another study notes that because of the imbalance in technological progress, where there is an inability to replace routine tasks with information technology, there is an increase in wages and employment in low-skilled services (Autor and Dorn, 2013). Individual researchers in Europe also tend not to dramatize the effects of extensive workplace automation (Arntz et al., 2016; Pouliakas, 2018). In Germany, research suggests that no more than 13 to 15 percent of the workforce is at risk of automation (Arnold et al., 2016; Dengler and Matthes, 2018) OECD researchers also tend to believe that no more than 10% of those employed in the U.S. economy are exposed to automation (Nedelkoska and Quintini, 2018). Exploring the practical application of robots and artificial intelligence (Vermeulen et al., 2018), a group of authors notes that this is a "common structural change" because the occupations affected by the effects of new technologies account for no more than 20% of jobs. In analyzing German industrial practices regarding the use of robots between 1994 and 2014 (Dauth et al., 2018), the authors note that the use of robots led to a loss of manufacturing jobs, but this was offset by gains in the business services sector.

An important feature of the digital economy is the increased demand for more skilled labor. Therefore, we should expect a new stage of labor market evolution caused by the transition to a high-tech and knowledge-intensive digital economy, in which the main labor force will be concentrated in STEM (Science, Technologies, Engineering and Mathematics) industries. Thus, McKinsey Global Institute experts predict that by 2020, companies in STEM industries around the world will need about 40 million highly skilled professionals, but 100 million middle-skilled people will be out of work.

Another feature will be the qualitatively new role of technological progress generated by the 4th industrial revolution – the uneven increase in the productivity of the main factors (capital and labor) of economic growth. Empirical evidence over the past 40 years shows that median income in a number of developed countries stopped growing in the 1980s, although for decades before it had been growing in proportion to productivity, following the growth of the latter. This process accelerated after the 2000s. While the median wage stagnated before 2000, it has now begun to decline, although the aggreagate factor productivity in developed economies has been rising steadily all along (Brynjolfsson and McAfee, 2014). Such inequality increases as a result of two forces: a) growing gap between labor income and capital income, and b) growing gap between high-income and low-income families (Leipziger and Dodev, n.d.). Appealing to data on the U.S. economy, they emphasize that the share of domestic income that goes to labor remunerarion has been declining since the early 1970s, as the share that goes to capital (interest, dividends, realized investment income, capital gains) has increased. This trend in the ever-decreasing share of gross domestic income devoted to the labor force (wages and salaries) since its peak in 1970 explains the expansion of inequality in the United States in recent decades. We should expect this process to worsen in the 2020s as digital technology destroys jobs faster than it creates them, thereby increasing unemployment and causing the median income to fall further.

Universal basic income as a symptom of social discomfort

The idea of basic income, of course, is not new. A recent work by the World Bank (Gentilini et al., 2019) provides a brief historical sketch of the evolution of social protection systems, from poverty alleviation in the 16th century to the explosive growth of social assistance programs in the 21st century. The authors of the study rightly note that social protection systems, due to the inertia of institutions and political structures, require time to adapt to rapidly changing structural changes brought about by demographic and technological factors. It is the need to rethink the role of the social protection system, according to the authors, that is one of the key reasons for the growing discussion of the concept of universal basic income (UBI) as a possible platform for a new system of social protection. It must also be recognized that interest in UBI is a symptom of serious social discomfort, as even in developed countries there is unequal access to education and health systems, widespread low-wage and low-productivity work, poorly functioning markets, corruption, regressive tax laws, unequal pay, and social discrimination (Piketty, 2016).

It must be admitted that even during the period of rapid economic growth after the war, when many Western European countries were practically implementing the idea of building a welfare state, their social protection systems were the object of constant criticism. It is therefore no coincidence that the introduction of a universal basic income for all adult citizens was seen by F. Hayek as an "economic security cushion" (Hayek, 2021). M. Friedman proposed supplementing the income of the poor segment of population with their unused income tax benefits and deductions, which he called a negative income tax (Friedman, 1966). E. Atkinson viewed basic income as a realization of the principle of social protection and provision of a decent minimum income (Atkinson, 2011). However, such estimates of basic income, while widely used, are not dominant. A number of researchers consider basic income an "immoral idea" and, appealing to the successful experience of economic reform in India, observe that without work people will engage in undesirable activities, from petty crime and gambling to terrorism (Aiyar, 2017). Other arguments of UBI opponents include its high cost to the economy, need for substantial tax increases and cuts in other social programs, and the very reduction in the workforce, which would negatively impact economic growth (Minogu, 2018). Another strong argument by opponents of UBI is the lack of nationwide projects to test basic income, although there are a significant number of countries where such experiments have been conducted within individual administrative units or have been the subject of national referendums.

In June 2016, 76.9 percent of Swiss voters rejected a proposal for a guaranteed basic income for all after a difficult debate about the future of work in a time of increasing automation. In Finland, the experiment was slightly different: 2,000 unemployed people selected at random for 24 months (from January 2017 to December 2018) received monthly payments of 560 euros to encourage them to find permanent employment. Thus, this project was aimed at combating unemployment. The Finnish government declared the experiment unsuccessful and closed the issue of UBI. As we can see, even in such social states as Switzerland and Finland, the idea of UBI did not find broad support (Gotev, 2016; Valero, 2019). In the Netherlands, opinion polls show an increasing number of supporters of basic income (De Roo, 2021). Similar projects are under development in Denmark, France, Catalonia and Scotland, Corsica and Portugal (Wispelaere and Haagh, 2019). In Italy, the Association for introduction of a subsistence income (AIRE) proposes to set the level of such income in the range of 400 to 800 euros per month, depending on different scenarios for their implementation (De Basquiat, 2016). In February 2017, the European Parliament voted 328 times against a universal basic income to compensate for the losses from the use of robots in the labor market. However, the idea of a basic income itself is gaining significant traction among the general public, with support for a basic income averaging just over 50 percent in the European Social Survey (ESS) wave (Lee, 2018). Negative attitudes in the very idea of UBI are expressed by researchers from the United States (Kearney and Mogstad, n.d.). They rightly point out that trends such as growing inequality, elimination of high-paying jobs due to the use of robots, and complex systems of social benefits have objectively contributed to the question of UBI. However, the idea of UBI is sub-optimal in their view, and perhaps a harmful political answer to all three of these problems because of its extremely high cost and inability to address inequality. This position of the authors, however, did not prevent them from calculating the approximate cost of the UBI program on a national scale. Their calculations show that, depending on the UBI scenario chosen, federal spending would range from $1.2 tln. to $2.49 tln. This significantly exceeds the volume of current payments under various social programs of the federal government (about USD 1 tln.). In another paper (Hoynes and Rothstein, 2019), the authors specifically note that the motivation for using UBI is a labor market situation where there has not been adequate wage and income growth for those workers at the bottom of the income distribution curve for a long time. The authors believe that it is the long, decades-long stagnation of wages and fears about widespread automation and the use of robots, as well as dissatisfaction with the current social safety net, that are causing increased interest in the UBI in the United States and other countries.

International Labor Organization (ILO) regards the UBI as a radical proposal for social assistance, where an unconditional cash transfer is guaranteed to all residents. In this regard, they highlight key ILO principles and standards to which UBI itself should approach: (i) the adequacy and predictability of UBI benefits to ensure a guaranteed income, set at least at the national poverty level; (ii) social inclusion, including those in the informal economy; (iii) social dialogue and consultation with stakeholders; (iv) adoption of national laws regulating UBI rights, including indexation of benefits; (v) consistency with other social, economic, and employment policies, and (vi) sustainable and equitable funding [50]. At that, ILO experts emphasize that UBI could replace general social security and unemployment benefits, but should not replace basic public social insurance, health care, education, other important social services, and programs for people with special needs (e.g., additional support for disability-related expenses) (Ortiz et al., 2018).

The Russian segment of research recognizes the process of labor market polarization, but all papers devoted to quantitative estimates of automation and labor substitution are characterized as controversial, and therefore most alarmist forecasts seem unfounded, and the risks of automation and significant changes in the labor market in Russia are estimated as lower than in developed countries (Lyashok et al., 2020). Such estimates are given against the background of Russia's significant lagging behind many countries in Europe and North America in terms of economically active life expectancy and short life expectancy (Denisenko and Varshavskaya, 2017). We must also take into account the fact that Russia, like all other countries in the world, is subject to the natural process of population aging, which will inevitably lead to the need to develop a new mechanism of interaction between demographic and macroeconomic variables (Kapeliushnikov, 2019). Given this broad palette of opinions, it is suggested that basic income be seen not so much as an economic, social, and even political phenomenon, but as something new that could actually change the whole social policy in the broad sense (Gontmakher, 2019). The introduction of basic income is also associated with certain additional costs related to their administration, but these costs are justified because they reduce the information asymmetry arising in the relationship between the state and recipients of social assistance (Kuznetsov, 2019). The implementation of the concept of basic income in Russia is also dictated by the need to reform the extremely complicated system of social support, when a significant part of the poor (according to Rosstat estimates – 15%, according to the World Bank estimates – much more) is excluded from the social support system (Gontmakher, 2019).

Results and Discussion

Conditional basic income as an economic policy instrument

Current trends in technology (development of the internet, data processing systems, NBIC technologies, robots, artificial intelligence, electronic platforms, digital technologies) have a direct impact on the economic environment and the development of the social landscape: increasing economic inequality; changes in the structure of the labor market and employment system; a growing wage gap between highly skilled and unskilled labor; and the elimination of many types of occupations. The considerable empirical material accumulated so far on the processes of digital transformation in the context of different economies, together with new stylized facts, may serve as a basis for developing a system of mathematical models describing key economic trends in the era of digital transformation.

We use the modified Mankiw-Romer-Weil neoclassical model with human capital as our baseline model to describe long-term economic growth (Mankiw et al., 1992). We introduced a special parameter to account for the increasing contribution of knowledge and information to the production of innovative goods and services, to account for the increasing returns generated in high-tech knowledge-intensive industries (Arthur, 1996). We also obtained a formula for calculating the joint share of physical and human capital in national income, which, based on the equality of the net marginal product of physical capital to the net marginal product of human capital (Barro and Sala-I-Martin, 2003), more accurately estimates the share of physical capital in national income. All of this made it possible to generate:

– a basic model of economic growth, taking into account physical capital and the exogenous mechanisms of capital's share of national income and technological progress;

– a model of economic growth that takes into account both physical and human capital, and the endogenous mechanisms of formation of the shares of physical and human capital in national income as well as technological progress, from which estimates of potential GDP and jobs may be obtained under given scenarios of wage rates and basic income levels required for a sustainable economy.

Based on World Bank statistics for physical capital and GDP of the US economy for 1982–2018, coefficient estimates for models of physical capital accumulation in the 21st century were derived using c.a.m.

Thus, we have calculated a forecast of the potential number of jobs in the US economy – $L_p(t)$. Its chart is shown in Fig. 1. This figure also shows the projected employment curve with technological replacement $L_{CK}(t)$ and robotization of production $L_{CKR}(t)$ under the capital share scenario.

As Fig. 1 shows, if the current economic model remains unchanged, about 100 million additional jobs could potentially be created by 2050, while the new development model, based on the widespread digitalization of all areas of life, will see a modest increase in jobs until 2025, and then a gradual decline to a minimum level comparable to the crisis year of 2009 – around 140 million jobs. As Fig. 1 shows, digital technology is cutting four times as many jobs as robots.

Fig. 2 shows the projected growth trajectories of potential US GDP up to 2050, calculated under different scenarios of declining employment Y_{CK}, Y_{CKR}, Y_{rd} (see Fig. 2) and accelerated K-capital accumulation. As can be seen from examining the charts in Fig. 2, the technological replacement of labor for capital slightly reduces the potential level of GDP, but not by much. We calculate a curve Y_{rd} showing the real aggregate demand for goods and services. As Fig. 2 shows, GDP rises slightly until 2025, athen starts to fall. As a result, the gap between potential output and aggregate real demand will widen gradually to around $20 tln or 54% of GDP by 2050. In the digital economy, then, it is demand that will begin to play a key role and will be the main constraint on GDP growth.

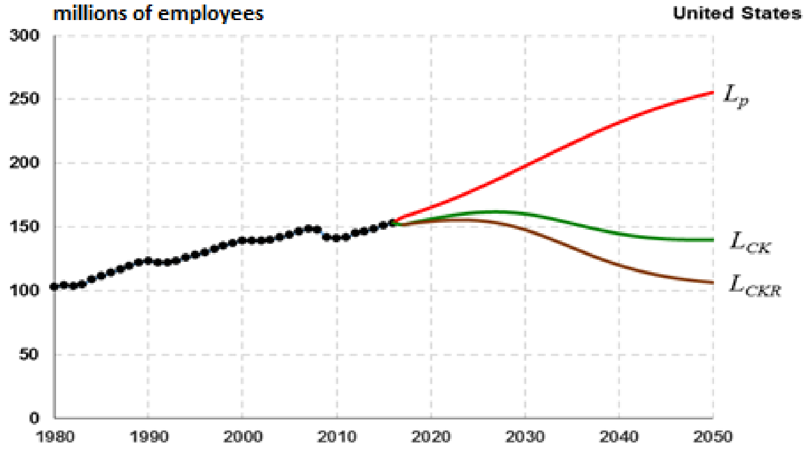

Fig. 1. Projections of the number of the employed in the US economy, allowing for the technological replacement of jobs (L_{CK}) and production robotization (L_{CKR})

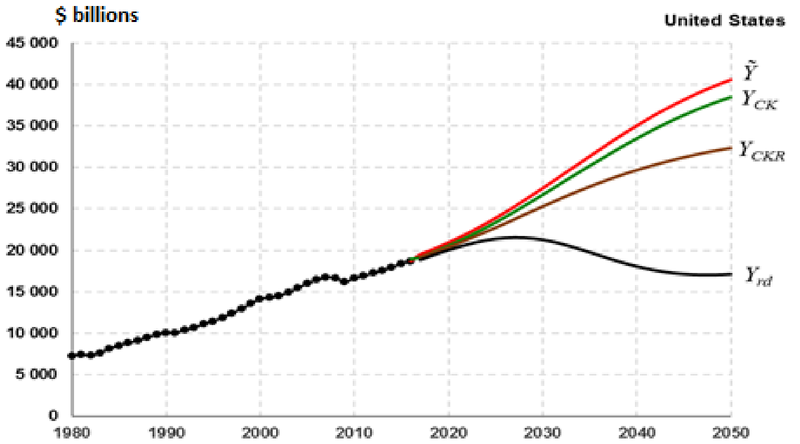

Fig. 2. Forecast of GDP dynamics allowing for technological replacement of jobs (Y_{CK}, Y_{CKR}) and falling demand from the households (Y_{rd})

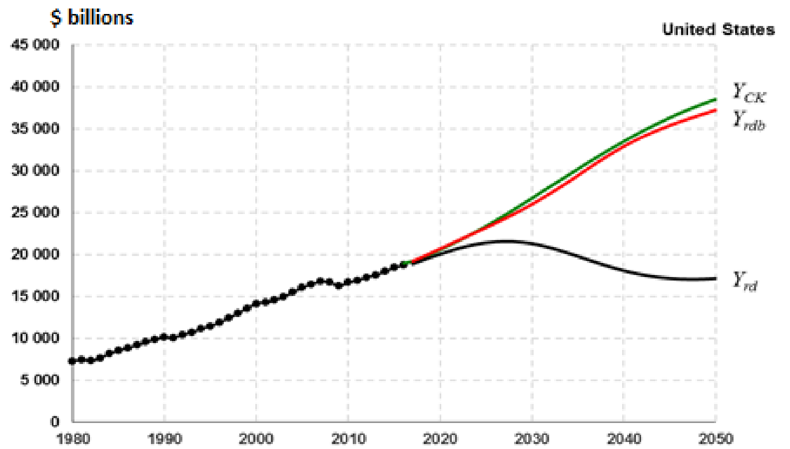

Fig. 3a. Restoring the potential amount of aggregate demand of households (Y_{rdb}) by introducing a basic income (Y_{Nb})

The growth trajectory of aggregate household demand including UBI and the growth curve of UBI itself are shown in Fig. 3.

As Fig. 3b shows, to compensate for the decline in aggregate demand, a universal basic income of \$50 per person per month is required and then ramped up logistically: in 2025 – \$500/person/month; in 2030 – \$1000/person/month; in 2035 – over \$2000/person/month; in 2040 – over \$3000/person/month; and in 2050 – already over \$4000/person/month.

The projected growth trajectories of potential US GDP to 2030 under different accelerated capital accumulation scenarios K are shown in Fig. 4a and 4b.

Estimates for 2030 show a potential GDP value Y_p of \$23.7 trillion with 164.1 million jobs. L_p Table 1 shows projections for the US economy in 2030 under the scenarios considered.

The growth trajectory of aggregate household demand including UBI and the growth curve of UBI itself are shown in Fig. 5a and 5b.

The difference in approaches to determining the nominal wage between the 2 scenarios is also evident at the level of the calculation of the required UBI. The calculations confirm the conclusion that there is a smaller gap between real demand and supply under the hypothetical scenario – the amount of funds

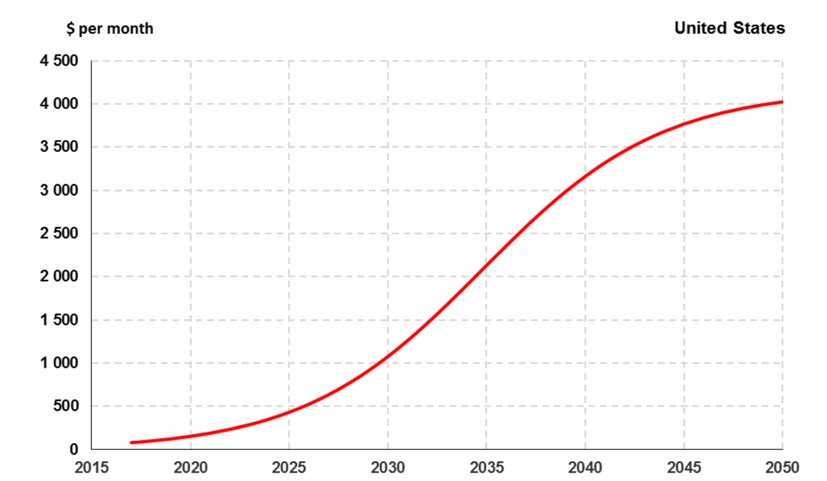

Fig. 3b. Dynamics of annual basic income r_b

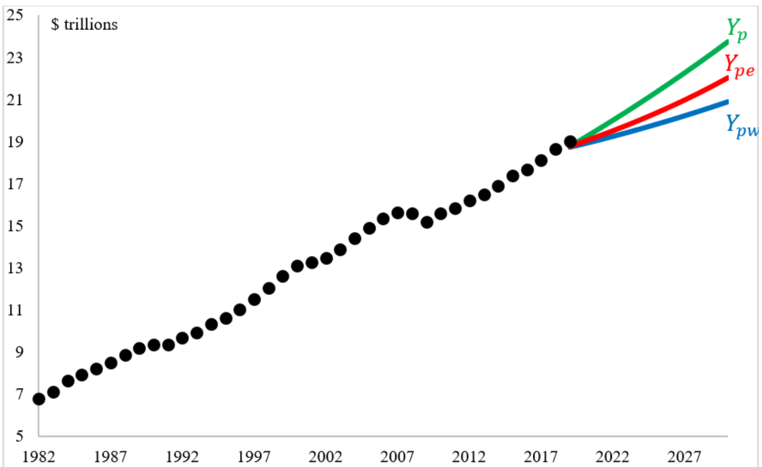

Fig. 4a. Forecasts of GDP dynamics taking into account technological replacement of jobs (Y_{pe}, Y_{pw})

needed to restore demand averages 18.19% of the projected GDP for the empirical scenario and 17.01% for the hypothetical scenario. This fact has an impact on the UBI value – according to our calculations, with the assumption of simplifications in the hypothetical scenario, the initial UBI of $860/month per person over 10 years would increase by about $160, whereas the empirical scenario calls for both a higher starting level of UBI ($880/month per person) and an annual increase to $1,200/month in 2030.

Overall, the resulting projections are consistent with the postulates about the impact of digital transformation on the economy and the new stylized facts. Accelerating technological progress, automation and robotics are having a negative impact on the labor factor. Under these conditions, the evolution of economic development indicators (GDP, real demand, number of jobs) is inversely proportional to changes in the real wage rate. On the other hand, an increase in pay has a positive effect on smoothing out inequalities and reduces the required UBI value.

When discussing the results of the modelling, it is necessary to compare them with existing estimates. According to projections of the U.S. Congressional Budget Office (*U.S. Congressional Budget Office*, 2020, potential real GDP of the US by the end of 2030 would be $23.3 trillion, a 1.7% difference from

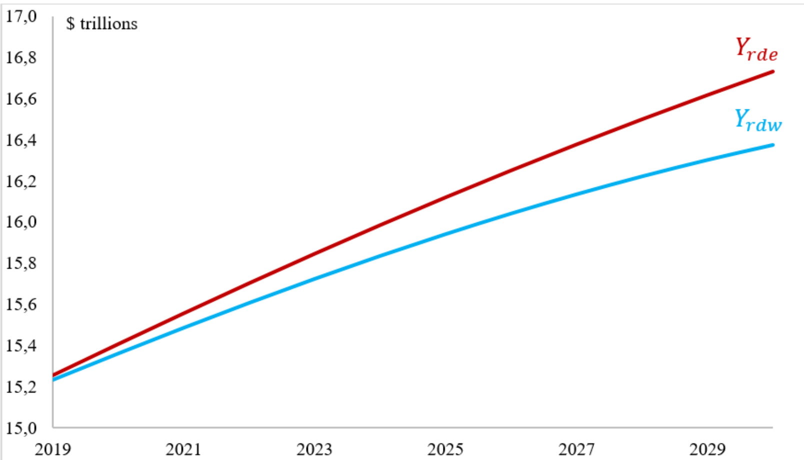

Fig. 4b. Projections of real household demand dynamics (Y_{rde} and Y_{rdw})

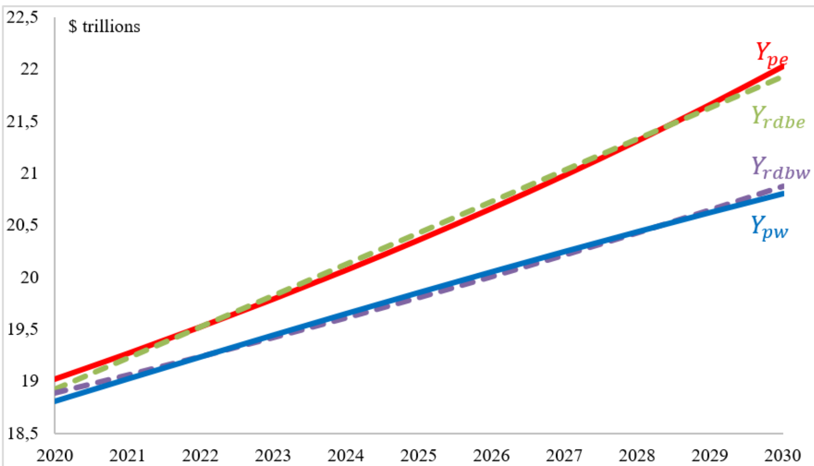

Fig. 5a. Restoring the potential amount of aggregate demand of households (Y_{rdb}) by introducing a basic income (Y_{Nb})

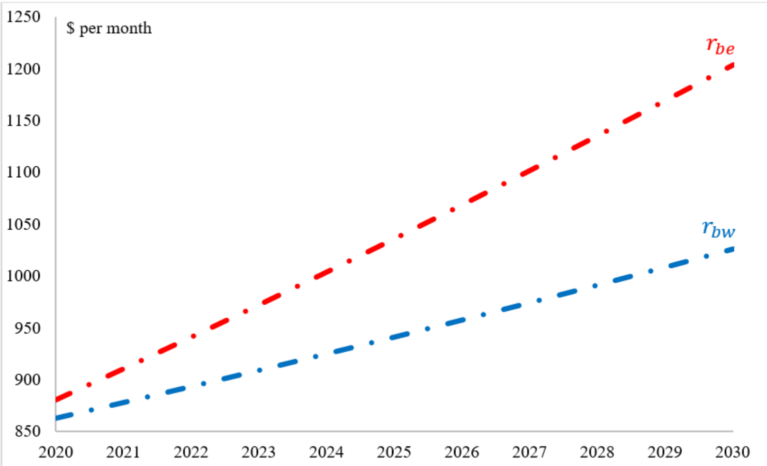

Fig. 5b. Dynamics of annua l basic income r_b

Table 1. Forecast for US economic indicators for 2030

Indicator	Scenario	
	Empirical	Hypothetical
Number of employees (million), including:		
– technological job replacements	152.2	144.3
– production and management robots	138.3	130.3
GDP, taking into account technological substitution of jobs ($ trillion)	22	20.9
Households real demand ($ trillion)	16.7	16.3

the value derived from our model. The alternative estimate proposed by the OECD (OECD, 2018) is $21.9 trillion, which is almost identical to our empirical scenario projection. Thus, accounting for different scenarios of wage rate dynamics in our model allows to generate an interval of reasonably adequate estimates of future GDP.

On the other hand, according to calculations made by the Bureau of Labor Statistics ("Bureau of Labor Statistics. Employment projections — 2018–2028," 2019), the number of jobs in the US economy by 2028 will be 169.4 million – 6% higher than our forecast for the same year. In our view, this divergence underscores the importance of the digital transformation of the economy and the search for tools to describe it.

Estimating the UBI level using the models we developed, we obtained an initial value of $860–880 per month per person in 2020 and projected values by 2030. Calculations under our proposed model showed that the annual cost per person should be around $10–12,000. This amount is close to what is currently being articulated in the research environment, for example in a study (Kearney and Mogstad, n.d.). These calculations show that, depending on the chosen UBI scenario, federal budget expenditures would range from $1.2 trillion to $2.49 trillion (5.85% to 12.15% of GDP) (5.85% to 12.15% of GDP).

Conclusion

The verification of the proposed models for the US economy shows that the model values are consistent with the real values. Our proposed modification of the simplest production function based on current views of economic development – taking into account human capital, according to Stiglitz, and the increasing returns generated by high-tech knowledge-intensive industries, according to Arthur – is adequate and can be used in practice. The introduction of UBI would certainly require redistribution of income from the rich to the poor, increased proportional income taxation, and possibly the introduction of a capital tax, as T. Piketty suggests (Piketty, 2016). However, we have to assume that the digital economy is the era of demand and with sufficient and varied supply from producers of goods and services, it is the satisfied and paid demand that will determine the sustainability of the growth of the economy as a whole.

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Статья поступила в редакцию 12.12.2021; одобрена после рецензирования 01.03.2022; принята к публикации 01.04.2022.
The article was submitted 12.12.2021; approved after reviewing 01.03.2022; accepted for publication 01.04.2022.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2022.1.1.2

INTEGRATION OF INFORMATION AND MANAGEMENT TECHNOLOGIES

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Abstract. Integration of management and information technologies is a task of increasing relevance for enterprises of all types, especially in view of the work in the changing world around us. This article reviews the state of affairs in this area and provides an overview of the current state of practice-oriented, research and educational approaches. It also describes the work of the Graduate School of Business Engineering (GSBE) of Peter the Great St. Petersburg Polytechnic University and describes the capabilities of Technoeconomics journal, which is created to exchange expert opinion and experience for the development of approaches to the integration of management technologies and IT.

Keywords: business engineering, business informatics, digital technologies, industry 4.0, enterprise architecture, education

Citation: Ilin I.V. Integration of information and management technologies. Technoeconomics. 2022. 1 (1). 24–32. DOI: https://doi.org/10.57809/2022.1.1.2

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2022.1.1.2

ИНТЕГРАЦИЯ ИНФОРМАЦИОННЫХ И УПРАВЛЯЮЩИХ ТЕХНОЛОГИЙ

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Аннотация. Интеграция управленческих и информационных технологий является задачей все более актуальной для предприятий всех типов, особенно с учетом работы в меняющемся мире вокруг нас. В данной статье рассматривается состояние дел в этой области и дается обзор современного состояния практико-ориентированных, исследовательских и образовательных подходов. Также описывается работа Высшей школы бизнес-инжиниринга (ВШБИ) Санкт-Петербургского политехнического университета Петра Великого и описываются возможности журнала «Техноэкономика», который создан для обмена экспертным мнением и опытом для разработки подходов к интеграции управленческие технологии и ИТ.

Ключевые слова: бизнес-инжиниринг, бизнес-информатика, цифровые технологии, индустрия 4.0, архитектура предприятия, образование

Для цитирования: Ильин И.В. Интеграция информационных и управляющих технологий // Техноэкономика. 2022. Т. 1, № 1. С. 24–32. DOI: https://doi.org/10.57809/2022.1.1.2

Introduction

Doing business in the information society requires from enterprises a high degree of adaptability to the constantly changing conditions of the environment. Under these conditions, the implementation of the strategic goals of the enterprise should be provided by a flexible and effective management system. The competitiveness of enterprises and countries in a globalized and open economy is largely determined by the management technologies used. Effective use of the latter allows businesses to adapt to changing conditions and respond quickly to the challenges of the macro-environment, thereby strengthening the competitive position of the enterprise in the micro-environment. Management technologies, combined with the opportunities provided by information technology (hereinafter – IT) and digital technologies, not only increase the efficiency of existing company processes, but also provide new tools for business management, allowing to implement processes and implement business models, the existence of which is impossible without the use of appropriate technologies.

This article aims to highlight the current state of development of approaches (in research, educational, and project aspects) in the field of integration of management and information technologies and to explain the relevance of such integration. A separate task of the article is to describe the possibilities of Technoeconomics magazine as a platform for exchanging expert opinion and experience in order to develop approaches in this sought-after direction.

Review

This section provides an overview of the current state of practice-oriented, research and educational directions, established schools and associations of researchers and practitioners engaged in and developing approaches to the integration of management technology and IT.

Business engineering and the concept of enterprise architecture

The role of applied management, information and communication and digital technologies for business success has become quite comparable to the importance of operational technologies, which are aimed at creating the product itself. The implementation of many business models in today's world without automation and digitalization is simply impossible.

When creating an enterprise from scratch, there is a unique opportunity to lay down in the foundation of the created enterprise such technologies, which will be the key to effective business in the future. Here we are talking not only about production technologies, but also about management technologies. In the conditions of globalization and free competition, it is management technologies that are often the key to the competitiveness of enterprises.

Designing and building a business is a more complex challenge than designing a production. There is still no single recognized standard for business design and creation. To solve these problems, modern organizational technologies, called business engineering, are now being applied around the world, using in management those achievements that work successfully in the design and management of technical objects, and make management accurate and effective. Business engineering is the activity to create, modify or reorganize an enterprise, based on an engineering approach that ensures the consistency of various enterprise components (strategy, structure, processes, information systems). Business engineering integrates and brings to practical solutions the findings of basic disciplines (such as systems approach to the management of organizations, quality management, enterprise architecture management), involves the use of technology (enterprise modeling, knowledge management, decision-making methods), builds on the principles and ideas of several more general disciplines (for example, systems engineering), generalizes the successful practice of real projects (Janssen, 2015).

Business engineering solves the problems of designing efficient enterprises based on the application of "mechanistic" approaches of technological engineering in the creation of socio-economic systems, which have proven their effectiveness in creating control systems of technical objects (Hoogervorst, 2018). The application of such technical approaches makes the process of creation and development of enterprises more accurate and efficient.

In accordance with the postulates of the systems theory, the systems perspective in the design of enterprises declares the need for a holistic view of the enterprise with an emphasis on the relationship between its constituent components (Giachetti, 2016; Röling, 2019). Business engineering relies on the concept of enterprise architecture as a model framework for the created enterprise, integrating heterogeneous classes of business elements. Enterprise architecture defines the overall structure and function of systems (business and IT) across the organization as a whole (including partners and other organizations that form the so-called "extended enterprise") and provides the framework, standards and guidelines for project-level architecture. The enterprise architecture model is designed to bring together technologies to manage various aspects of the business to create an integrated management system (Jaradat et al., 2017).

An important task of the theory and methodology of architectural business engineering is to offer such approaches to the design, implementation and development of management systems that will not only solve the problems listed above in existing enterprises, but also to prevent their occurrence in newly created or modernized (Saharuddin et al., 2019). Application of integrated approach to creation and development of enterprise architecture, which includes IT support as one of the key components, allows to create automated control systems in the context of general enterprise management system and in accordance with strategic goals and objectives of the enterprise.

Significant role of information and communication and digital technologies in modern business is undeniable. The use of information systems and technologies allows reducing time and increasing the efficiency of operations, carrying out effective data collection, processing, storage, transfer, analysis, and thereby improving the quality of management decisions based on the data (Iyamu and Shaanika, 2019). Implementation of information systems without proper coordination with the requirements of the management system is not effective: the requirements of business for IT support of its processes are the driver of the implementation of IT systems at enterprises (El Bilali and Allahyari, 2018; Prokopenko and Omelyanenko, 2018). As a consequence, at one time there was a need for approaches to the formation of an integrated enterprise management system, including IT as an integral part. The answer to the problems of alignment of business requirements and IT capabilities was the concept of enterprise architecture and its broader interpretation – corporate architecture.

The task of business engineering is to integrate into a single methodological complex such components of the enterprise architecture as:

– business processes and BI and ERP systems;
– production processes and MES-systems;
– Manufacturing processes, manufacturing equipment and APCS;
– IT architecture components (BI-, ERP-, MES-systems, APCS);
– Information systems and applications, production equipment (involved in the processes of information exchange of the enterprise) and IT infrastructure;
– implementation of solutions for data collection, storage, processing and analysis.

That is, it is reasonable to talk about the integration of management, operational and information technology within a single model of management system, which is the enterprise architecture model.

Business informatics as an educational field

Business Informatics (BI) is an interdisciplinary field that provides research and training in both business systems and information systems and technology.

The first training programs related to IT applications in business began to appear at German universities in the 1970s. It was during this period that the term "business informatics" itself emerged, which implied a focus on enterprise data and hardware-software issues. Now business informatics refers to organizations, processes, and the effectiveness of business technology applications (Paul et al., 2018). One of the foundational documents for BI is considered a Business Informatics Memorandum with a focus on creating artifacts (Österle et al., 2010). Well-known scholars in the field such as Peter Mertens, Hubert Oesterle, Jörg Becker, Ulrich Frank, Thomas Hess, Dimitris Karagianis, Helmut Krchmar, Peter Loos, Andreas Oberweis, and Elmar J. Sintz participated in its creation. The Memorandum enshrines basic principles for conducting research that are important in determining the current direction of BI science. Also developed is a Guide to Teaching Business Informatics by authors such as Peter Mertone, Dieter Ehrenberg, and others (Mertens et al., 1999). The first part of the guide defines modern BI. It provides an overview of potential graduate professional fields and forms recommendations for training. The second part of the Guide lists all BI programs at universities in Germany, Austria, and Switzerland. The Guide also provides a general portrait of BI practitioners, including the stories of various company executives and professors who are in one way or another associated with the study, teaching, and application of BI in their professional lives. The guide is significant in terms of contributing to the integrity of the understanding of various aspects of BI.

In Russia, the National Research University Higher School of Economics (HSE) and the School (formerly the Faculty) of Business Informatics initiated the creation and development of this field of study in response to the shortage of qualified personnel capable of effectively organizing complex IP in the commercial and public sectors. Today, BI is taught by more than 180 universities in Russia, and BI issues are discussed at many conferences. BI-related competencies are needed for IT project managers, business analysts, IT directors, and in general for all managers of modern enterprises.

Information Systems is not the only area that BI is concerned with. BI examines a variety of business support methods related to information, organizational, and infrastructure components. As businesses become more dependent on the IT solutions they use, the need for tools to control and monitor performance while solving assigned tasks and using allocated funds increases. At the same time, as IT's dependence on the business for funding increases, so do the requirements for possible benefits from IT, and the scale of the benefits can range from mere process improvement or automation to the creation and development of new areas of the company's business. In this regard, BI aims to foster dialogue between business and the IT world (Helfert, 2008).

Business informatics is a young scientific and practical direction that exists at the intersection of economics, management and IT. The formation of BI as an academic discipline and all stages of its development were driven by business demand for various applied solutions related to the collection, transmission, storage and processing of information for business purposes. At the moment, the development of BI largely depends on technological trends that have or will have a strong impact on the economy and society.

Thus, it is possible to state that the current position of BI in the economy and science is directly dependent on the needs of modern business. BI interests are shaped by the demand for various scientific applications that are available on the market at any given time. The dynamism of the discipline makes it possible to respond quickly both to the emergence of new technologies and to changes in the practices of commercial companies or in the behavior of consumers and their needs.

Thematic professional communities

There are a number of leading schools of business architecture around the world. A significant contribution to the development of the concept of enterprise architecture has been made by John A. Zachman (Zachman, 2003). Zachman's framework for describing enterprise architecture has served as the basis for a number of other techniques and models for describing enterprise architecture, such as FEAF – Federal Enterprise Architecture Framework, TOGAF – The Open Group Architecture Framework, DoDAF – Department of Defense Architecture Framework. Mark Lankhorst is a key developer of ArchiMate, an enterprise architecture modeling language, and a representative of the Dutch Architecture Forum in the Federation of Enterprise Architecture Professional Organizations (Lankhorst, 2013, 2004). The Open Group are the developers of The Open Group Architecture Framework (TOGAF), a methodology (framework) for describing enterprise architecture, offering an approach for designing, planning, implementing and managing enterprise IT architecture.

The National Research University Higher School of Economics (HSE) is traditionally widely engaged in the issues discussed. The interdisciplinary scientific journal "Business Informatics" is published.

Modern Management Technologies Group annually holds a unique conference "Designing Business Architectures" for organizational development and business process management professionals. The conference is dedicated to business systems design from conceptual level (description of business system goals, basic functions of business system) to detailed models (processes, organizational structure, material and information objects, personnel requirements, information systems and their functions).

The Graduate School of Business Engineering (GSBE) of Peter the Great St. Petersburg Polytechnic University is a vivid example of an established scientific and educational school in the field of business informatics not only in St. Petersburg, but also at the all-Russian level. The members of the research group actively develop approaches to designing, modeling and creating effective management architectures that meet the requirements of newly emerging business needs, in particular the need to integrate digital solutions and data handling systems into the enterprise architecture.

Conclusion

The effective integration of information and communication and digital solutions is now one of the key challenges of enterprise management. Given the ongoing digital transformation, automation is a necessary prerequisite for the effective transition to new, digital models in the implementation of activities. The implementation of information systems for business management and its individual elements requires a systematic approach, which implies the development of IT solutions in inseparable connection with the formation and development of an integrated enterprise management system. Design and development of IT-architecture of enterprises requires an appropriate methodological and methodological framework. The task of effective integration of management, operational and information technology is very relevant. In recent years, concepts and models describing the integration of digital technologies into the enterprise architecture have been actively developed.

Given the trends in the concept of the fourth industrial revolution, it is necessary to integrate operational, management and information technologies. The coordinated application of these three technologies is the key to the successful transition to a new way of doing business. Moreover, these types of technologies are consistent with the concept of enterprise architecture and reflect the logic of its formation. This makes the architectural approach a suitable basis for the development of a methodology to integrate these technologies within a single enterprise model. This model will be a development of traditional representations of enterprise architecture, taking into account the factor of digital transformation.

Service-oriented approach is considered as an approach to the formation of a balanced enterprise architecture, which allows to coordinate the mutual requirements of all interrelated layers, allocated in the architecture (Alho and Mattila, 2015; Rabelo et al., 2015). When designing and developing the architecture of the enterprise according to the service-oriented approach, the result of the enterprise activity is business services for external consumers, and the result of the activities of individual layers and elements of the architecture of the enterprise – services for internal consumers (Ameller et al., 2015; Rojas et al., 2021). Thus, services are the linking element between the layers of the enterprise architecture.

It is necessary to expand the theoretical and methodological base in this direction, based on the principles of systems theory, business engineering, enterprise architecture, information management, project management, process management. The trend towards digital transformation of business and, in particular, industrial enterprises (the concept of Industry 4.0) requires an integrated vision of various aspects of enterprise management within a single model: business and technological processes, information systems and technologies, data, production infrastructure.

These are the challenges facing the research and practice community in developing approaches to effectively integrate management and IT technologies. In order to realize this task, it is important to provide a full range of approaches development and implementation:

- Identification of current requests for the development of existing approaches;
- formation of methodological foundations;
- documenting and discussing the results;
- training of specialists.

Peter the Great St. Petersburg Polytechnic University seems to be an appropriate platform for the development of approaches in the field of integration of operational, management and information and communication technologies, because it has the capacity to develop and implement approaches in all of the above aspects. For example, researchers at GSBE within the framework of their project activities actively use the architectural approach to design and re-engineer management systems of enterprises in various industries (healthcare, logistics, mining and processing industry, IT-consulting, retail). This activity includes testing in practice and sectoral adaptation of existing approaches, identifying requests for the development of theoretical and methodological framework, and developing reference (sectoral) models of architectural solutions. Development of theory and methodology of business engineering is carried out by researchers of the school in the course of implementation of grants and initiative research financed by various funds, while writing PhD and doctoral dissertations by research team members and under their supervision. There is the Dissertation Council on the basis of GSBE. It is specialized in the field of business-engineering theory development (within the scientific specialty 08.00.13 Mathematical and Instrumental Methods in Economics). GSBE implements a complex of bachelor's and master's programs for training specialists in the field of enterprise architecture, including both classical methods and models and the results obtained by the teachers in the framework of their project-research activities.

The Technoeconomics journal, created on the basis of GSBE, logically closes the range of activities to ensure professional communication and exchange of experience in the issues of technology integration. The magazine, among other things, aims to become a platform for publishing practical and theoretical achievements in the field of business engineering, enterprise architecture, digital solutions, control systems and their mathematical support. The journal will strive to become a significant platform for exchange of opinions, experience, topical research of the best scientists and specialists in the field of business engineering, enterprise architecture, business informatics, etc.

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Статья поступила в редакцию 29.11.2021; одобрена после рецензирования 15.12.2021; принята к публикации 27.12.2021.
The article was submitted 29.11.2021; approved after reviewing 15.12.2021; accepted for publication 27.12.2021.

Technoeconomics. 2022, Vol. 1, No. 1. Pp. 33–42.
Техноэкономика. 2022, Том 1, № 1. С. 33–42.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2022.1.1.3

ANALYSIS OF HEALTHCARE IT SOLUTIONS WITHIN VALUE-BASED AND PERSONALIZED MEDICINE PARADIGMS

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Abstract. In the modern world, in the conditions of the dynamic development of technologies, the focus of attention of enterprises is directed not only on technologies for the implementation of core activities, but also on management technologies. The leading ideological concepts, under the influence of which a modern healthcare system is being formed, are: value medicine, personalized medicine, Health 4.0 concept. This article analyzes the models of IT solutions for IT support of the medical organization, which implements the principles of value and personalized medicine and following the development trends of modern digital technologies. The analysis of the key characteristics and features of IT support for this type of medical organization.

Keywords: IT support, value-based medicine, IT solutions, technology

Citation: Lepekhin A.A,, Iliashenko O.Yu., Gugutishvili D.M., Ershova A.S. Analysis of healthcare it solutions within value-based and personalized medicine paradigms. Technoeconomics. 2022. 1 (1). 33–42. DOI: https://doi.org/10.57809/2022.1.1.3

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2022.1.1.3

АНАЛИЗ ИТ-РЕШЕНИЙ В ЗДРАВООХРАНЕНИИ В РАМКАХ ЦЕННОСТНО-ОРИЕНТИРОВАННОЙ И ПЕРСОНАЛИЗИРОВАННОЙ ПАРАДИГМ МЕДИЦИНЫ

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Аннотация. В современном мире, в условиях динамичного развития технологий, внимание предприятий направлено не только на технологии осуществления основной деятельности, но и на технологии управления. Ведущими мировоззренческими концепциями, под влиянием которых формируется современная система здравоохранения, являются: ценностная медицина, персонализированная медицина, концепция Здоровье 4.0. В данной статье анализируются модели ИТ-решений для ИТ-поддержки медицинской организации, реализующей принципы ценностной и персонализированной медицины и следующей тенденциям развития современных цифровых технологий. Проведен анализ ключевых характеристик и особенностей ИТ-поддержки данного типа медицинской организации.

Ключевые слова: ИТ-поддержка, ценностная медицина, ИТ-решения, технологии

Для цитирования: Лепехин А.А., Ильяшенко О.Ю., Гугутишвили Д.М., Ершова А.С. Анализ ИТ-решений в здравоохранении в рамках ценностно-ориентированной и персонализированной парадигм медицины // Техноэкономика. 2022. Т. 1, № 1. С. 33–42. DOI: https://doi.org/10.57809/2022.1.1.3

Introduction

Today, a medical institution at any level needs modern management technologies. The pursuit of continuous improvement is the key to the gradual successful growth of the institution.

The modern world is characterized by the active penetration of information and digital technologies into all spheres of human life. Automation and digitalization have a significant impact on any activity, changing the established rules and procedures. Continuous improvement with the use of modern information and digital technologies, the introduction of innovations and the encouragement of employee initiative can become a significant incentive for promotion among competitors.

The main goal of healthcare management is to reduce social losses due to morbidity, disability and mortality. To achieve this goal, effective activity is required, both of the entire healthcare system, and of each medical organization, for which it is necessary to introduce other methods, principles, approaches and management models for absolutely all parts of the medical organization aimed at achieving the following interrelated goals:

– improving access to quality services and prompt medical care;
– improving the quality of life and public health;
– increase the profitability and profitability of the medical organization (Begkos et al., 2020).

However, not everyone understands and realizes the necessity and importance of economic efficiency and profitability for a public health organization. At the same time, practice shows that medical organizations that actively attract additional extra budgetary funds are the most effective.

Health management includes managing financial, labor and medical resources. In the healthcare sector, there is a tendency to increase the efficiency of healthcare institutions, therefore, it is necessary to introduce new modifications and ways to manage all elements of the organization (Siyam et al., 2019).

The leading concepts setting the development trend of the modern healthcare system are: value medicine, personalized medicine and the concept of healthcare digitalization Health 4.0 (Thuemmler and Bai, 2017).

Valuable medicine is a result-oriented approach to the organization of a health care system, which assumes that from among several options, one should choose the method of patient care that is expected to give the best result at a relatively lower cost.

This approach assumes that medical care should be provided primarily with a focus on value for the patient. Of course, such aspects of medical care as accessibility, convenience, service are also important, but they are of secondary importance (Brown et al., 2003). With this approach, ideally, those who provide medical services are paid for actually helping the patient improve their health, reduce the incidence of chronic diseases and their complications, and also contribute to a better health of society as a whole. Of course, this approach should be used with extreme caution, since in medicine there is a huge share of uncertainty in the result, and often the most correct approaches and best techniques may be ineffective due to force majeure circumstances or unpredictability of the patient's reaction. Moreover, some experts believe that prioritizing some quality criteria will underestimate others and cause an imbalance in the provision of assistance. But, nevertheless, changing the wage system in medicine and avoiding increasing aid volumes today is considered a key point that can increase its effectiveness provided that resources are saved, the acute shortage of which worries health systems around the world.

In conditions of existing trends in the development of health care, the urgent task is to develop a model of the medical organization that implements the principles of value-based and personalized medicine, takes advantage of the technologies of the Health 4.0 concept, and allows for quick and flexible response to dynamically changing environmental conditions.

The requirements for compliance with the principles of value and personalized medicine should be reflected in the model of business processes of a medical organization. The possibilities for applying technologies of the Health 4.0 concept set requirements for the structure of IT support and the technological infrastructure that ensures the implementation of processes.

This makes it urgent to analyze models of IT solutions for IT support of a medical organization, which implements the principles of value and personalized medicine and follows the development trends of modern digital technologies.

Materials and methods

A characteristic feature of the Health 4.0 concept is that it involves the introduction of modern digital tools and technologies (big data management, the Internet of things, blockchain, telemedicine, predictive analytics, etc.) in medical activities, in order to increase its accessibility and efficiency from various points of view (Ilin et al., 2020). In the realities of the modern world, most medical organizations are faced with the problem of lack of resources to process the ever-increasing flows of information. This is largely due to the fact that the existing management architecture in organizations, and one of its components – the architecture of information systems and applications, today does not meet modern requirements and conditions for building effective interaction with modern digital technologies (Borremans et al., 2019; Ilin et al., 2019; Lee and Youn, 2015).

Ensuring accessibility requirements for medical care and compliance with the principles of value and personalized medicine are directly related to the possibility of increasing economic efficiency. The provision of medical care that is adequate, according to the patient, to a particular case, creates the prerequisites for the efficient use of the resources of medical organizations. Modern management technologies, including digital ones, have significant potential in solving a number of problems on the way to providing more affordable, cost-effective and high-quality medical care.

Health 4.0 is defined as a strategic concept for the healthcare industry based on the Industry 4.0 concept (Bause et al., 2019, p. 0). The primary goal of Health 4.0 is to provide progressive virtualization to personalize patient health in real time. Personalization of healthcare will be achieved through the widespread use of cyber-physical systems, cloud computing, the Internet of things, predictive analytics, blockchain technology, streaming data from wearable devices, and various mobile systems (5G) (Cáceres et al., 2019, p. 0). To understand the benefits of using the concept in the healthcare sector, it is necessary to precisely define the main advantages and goals of using the concept of the fourth industrial revolution as a whole (Müschenich and Wamprecht, 2018). To date, the concept of "Industry 4.0" is one of the most significant organizational and technical systems. Such a solution involves the end-to-end digitalization of all existing physical assets and their subsequent integration into the digital ecosystem together with partners participating in the value chain (Hermann et al., 2016). The main strategy of the fourth industrial revolution is to expand the possibilities of relations between manufacturers and suppliers in various industries, which allows to increase the volume of individualization and personalization of customers.

The Industry 4.0 concept is defined by the following characteristics (Bartodziej, 2017, p. 4):

1. Digitalization and integration of vertical and horizontal value chains, from development and procurement to production, logistics and service. All existing data on the effectiveness of process control are available in real time in an integrated network. Horizontal integration allows you to reach suppliers, consumers and other key partners. Such integration uses a variety of technologies: from tracking and control devices to integrated planning integrated with real-time execution.

2. Digitalization of products and services, which includes the addition of existing products with various smart sensors or communication devices that are compatible with data analytics tools, as well as the creation of new digital products designed to provide comprehensive solutions. Due to the introduction of innovative methods of data collection and analysis, enterprises have the opportunity to obtain data on the use of products and modify these products in accordance with the new requirements of end users.

3. Digital business models and customer access, including comprehensive, personalized, data-driven services and integrated platforms. The main focus of new business models is to obtain additional profit from digital solutions, optimize interaction with the client and improve customer access (Kagermann et al., 2013).

This research paper will review technologies related to Health 4.0 from various global software and hardware vendors in order to analyze general trends in building the structure of IT support.

Results

The implementation of information systems and technologies at various types of enterprises, as a rule, is based on goals related to solving the most important business problems. An analysis of organizations in the healthcare sector showed that such tasks from the point of view of management include:

1. Improved diagnosis / treatment. The institution is not only a platform for the introduction of new technologies, but also achieves a significant improvement in the results of applying traditional approaches by using predictive modeling methods based on patients' medical data to select the optimal treatment depending on individual characteristics and organizational decisions.

2. Organization of “seamless” patient flows. Effective organization of patient flows means a reduction in waiting time and length of hospital stay, increasing the satisfaction of patients and doctors with the care process. The information system is configured to identify bottlenecks, analyze the causes and develop approaches to address them, which contributes to the optimal distribution of patient flows.

3. The active use of distance medical technologies and hospital to home technologies. One of the key tasks of remote monitoring methods is to expand the boundaries of the hospital with the possibility of further assistance to the patient at home. For these purposes, there are various medical devices – wearable, implantable, portable. But their main task is to provide information about certain vital functions of the patient (blood pressure level, electrical activity of the heart, oxygen saturation of the blood, glucose level, etc.) in real time to the clinic. Some devices are associated with additional therapeutic options, such as remote control of the dose of the drug. The most promising is the use of remote rehabilitation technologies, including during orthopedic operations, after a stroke, etc. This significantly reduces the need for patients to be hospitalized and, consequently, reduces the cost of providing care, along with an increase in patient satisfaction with the opportunity to receive the necessary help. at home. Data from wearable devices and applications originating from patients is medical information, a description of symptoms, biometric indicators, medical history, lifestyle indicators that are collected, recorded by the patient or his relatives. It is important to note that these data were collected outside the medical care process, because patients (not medical personnel) are responsible for collecting information and its quality, as well as maintaining its confidentiality (unless they are part of the services provided by the "smart clinic") (Iljashenko et al., 2019). The advent of affordable wearable devices, sensors, and data transfer technologies, such as patient portals, provides a unique opportunity for long-term, continuous monitoring of daily activity and indicators of patients with chronic diseases. This promotes the involvement of patients and their relatives in the care process and the development of a continuously learning health system. Data from wearable devices can potentially fill many existing information gaps and provide a unique opportunity to track the patient's condition and his adherence to treatment between visits to the clinic.

4. Improving patient safety. Improving the quality of medical care and the proper organization of patient flows leads to increased patient safety.

5. Reliability. A good reputation is a competitive advantage when choosing between different organizations. Reliability is also determined by the level of adherence to treatment and the creation of an integrative care system for patients, as this affects the results that a medical organization can achieve.

The world's largest software manufacturers, SAP, Microsoft, Oracle, etc., when developing IT solutions for the healthcare sector are guided, first of all, by the need to implement the ideas of value and personalized medicine. The main goal of modern IT solutions is to maintain a balance between medical and economic efficiency of a medical institution. It is important to provide cost-effective treatment, create a digital network for the new consumer-centric healthcare ecosystem, and enable real-time information exchange between healthcare providers and patients. It is necessary to maintain a more personalized interaction between patients and a medical organization at all stages of the process, from prevention and diagnosis to treatment and postoperative care.

SAP IT-solutions

Digital technologies help the healthcare industry forecast the demand for medical services and provide real-time services, optimize the provision of preventive care and treatment, and give patients the opportunity to better control their health. Frequent changes in patient service quality standards require quick and constant adaptation by medical organizations, insurance companies, life sciences organizations, and software developers. There is a health ecosystem focused on the concept of Health 4.0, which goes beyond traditional management systems.

A modern consumer of medical services is informed, proactive, and is included in a single digital space for interaction with representatives of medical organizations. According to the CEO of SAP SE Healthcare Providers, SAP is developing digital solutions to bring patients and the healthcare industry closer together, using high technology to achieve more personalized care ("SAP SE. SAP Software Solutions | Business Applications and Technology.," n.d.).

SAP's experience in digitally processing every aspect of the customer value chain is designed to help healthcare stakeholders improve their customer service delivery at an affordable price.

The SAP solution for the healthcare industry consists of 3 main modules:

1. patient care – the patient care module is focused on solving many problems, such as organizing access to personal and medical data of a patient directly in real time, including using mobile devices; improving the overall health of patients while controlling costs.

2. collaboration in the field of healthcare – ensuring collaboration between providers and consumers of health services contributes to the promotion of health and well-being and reduces hospital visits. To ensure collaboration, this module helps to manage patient transitions from one healthcare provider to another when moving through the network, identify health problems before the patient needs to be in the hospital, and monitor patient redirection to maintain them within the network. This reduces the number of hospital visits, and collaboration between healthcare providers and consumers becomes more active. The healthcare collaboration module includes 2 submodules: patient involvement and patient relationship management.

3. health analytics and research – the main purpose of the application is to consolidate health data from various sources. The application includes 3 submodules: Healthcare Analytics, Medical Research Insights, Connected Health.

Thus, SAP IT solutions for healthcare include special solutions related to medical activities (Patient care, Care Collaboration, Healthcare Analytics and Research), and solutions supporting financial (Finance), human resources (Human Resources) and procurement (Procurement) activities. SAP provides IT architecture components with analytics solutions, application platform and infrastructure, information and database management, database and data management, IT management, and security software (Security Software), the Internet of Things and technology services (IoT Business and Technology Services).

Microsoft IT-solutions

Microsoft IT solutions implement the concept of Mental Health. The company provides Microsoft Digital Transformation for Health.

This solution improves patient care and allows them to receive medical care outside the home, anywhere in the world. With the help of wearable sensors and service solutions, the number of repeat visits is reduced, and doctors are able to provide timely preventive care. Microsoft solutions empower the digital healthcare industry.

This is a single integrated platform that combines several solutions ("Microsoft Collaborative Health: Healthcare Solutions," n.d.):

– Health360 Care Coordination – coordination of patient care.
– Microsoft Dynamics 365 Sales and Field – A solution for field sales and service.
– Power BI – business intelligence.
– MS SharePoint – a platform for developing a corporate portal and managing corporate content.
– MS Azure – Microsoft's cloud platform.

The need for the continuous development of the healthcare system is constantly growing with limited resources. In addressing the issues of improving the quality of medical services, digital e-health solutions are becoming an integral component of the digital transformation of a medical organization.

Conclusions

Thus, after analyzing the decisions of the world's largest software vendors, several key features of the structure of IT solutions were formed to support value-based and personalized medicine.

– Integration and connectivity to other products. As a rule, the IT landscape of any medical organization is characterized by the integration of many different information systems into a single environment. In this regard, it is necessary to check that the selected information systems will be able to use different types of databases (SQL, NoSQL), work with different versions of existing data storage and transmission standards (XML, JSON), and will also provide integration with software from various vendors, primarily large ones, such as SAP, IBM, Oracle;

– Performance. It is extremely important to assess in advance the amount of data that will be stored and transmitted in information systems, as well as to estimate the approximate number of users who will use information systems at the same time in order to calculate the values of peak loads for the entire IT landscape of the organization;

– Security. It is known that the specificity of medical activity involves the collection and storage of a large amount of personal data of patients, which are confidential and protected by medical confidentiality and medical ethics. In this regard, systems that work with personal data must meet certain requirements. Firstly, they should be able to customize roles and access rights to data, and secondly, it should be possible to partially isolate these systems from the "outside" world, without interrupting interactions with other systems used in the landscape;

– Reporting. Reporting documentation is an important aspect that accompanies most types of activities, including medical. However, filling out these documents often takes up a huge amount of working time from doctors, and accordingly, the time that a specialist can spend on treating a patient is reduced. In this regard, it is important that the process of preparing documents is automated as much as possible through the use of information systems, which will increase labor costs for the direct responsibilities of employees;

– Using cloud technology. Modern medical organizations use a large number of different sensors and equipment that allow them to monitor and regulate certain processes remotely. To ensure effective remote interaction in the IT landscape of a medical organization, systems and services must be provided that will partially or fully function in the cloud (Catarinucci et al., 2015; Meng et al., 2011; Piniewski et al., 2010).

The main advantage of modern technology is that it integrates the entire medical environment, thereby offering physicians a detailed understanding of the aspects needed to improve diagnosis, treatment and patient care. While the use of technology influences various indicators of health outcomes, such as reducing costs, the introduction of technology without proper planning can lead to a number of problems. For this reason, several important aspects need to be considered, including the preparedness of the organization, a good understanding and knowledge of modern technologies, and taking into account the risks of digital technologies. Reforming the activities of medical organizations, caused by the need to introduce modern management technologies, in accordance with the concept of enterprise architecture, should be carried out systematically, taking into account the interconnections and interdependencies of all elements of the organization's management system.

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Статья поступила в редакцию 08.11.2021; одобрена после рецензирования 11.12.2021; принята к публикации 12.12.2021.

The article was submitted 08.11.2021; approved after reviewing 11.12.2021; accepted for publication 12.12.2021.

Technoeconomics. 2022, Vol. 1, No. 1. Pp. 43–53.
Техноэкономика. 2022, Том 1, № 1. С. 43–53.

Scientific article
UDC 65.011.56
DOI: https://doi.org/10.57809/2022.1.1.4

AUTOMATIZATION OF A LOGISTIC PROCESS USING PLATOONING TECHNOLOGY FOR CARGO TRANSPORTATION FROM FINLAND TO SAINT PETERSBURG

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Abstract. The world we live in is changing dramatically through innovation, and the pace of change is accelerating every day. Truck platooning is the linking of multiple trucks in a convoy using communication and sensors between vehicles. Platooning technology can allow vehicles to move completely autonomously. One of Russia's major trading partners is Finland. Active cargo transportation of products is carried out in both directions. Truck platooning can be used on this road. This paper includes the costs analysis of the technology and how it may pay for itself in the future.

Keywords: platooning, cooperative traffic system, highway automation, vehicle to vehicle communication

Citation: Malysheva T. Automatization of a logistic process using platooning technology for cargo transportation from Finland to Saint-Petersburg. Technoeconomics. 2022. 1 (1). 43–53. DOI: https://doi.org/10.57809/2022.1.1.4

Научная статья
УДК 65.011.56
DOI: https://doi.org/10.57809/2022.1.1.4

АВТОМАТИЗАЦИЯ ЛОГИСТИЧЕСКОГО ПРОЦЕССА С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИИ ПЛАТОНИНГА ДЛЯ ПЕРЕВОЗКИ ГРУЗОВ ИЗ ФИНЛЯНДИИ В САНКТ-ПЕТЕРБУРГ

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Аннотация. Мир, в котором мы живем, резко меняется благодаря инновациям, и темпы этих изменений увеличиваются с каждым днем. Группа грузовиков — это объединение нескольких грузовиков в колонну с использованием связи и датчиков между транспортными средствами. Технология платонинга позволяет транспортным средствам двигаться полностью автономно. Одним из основных торговых партнеров России является Финляндия. Активные грузоперевозки продукции осуществляются в обоих направлениях. На этой дороге можно использовать платонинг грузовиков. Этот документ включает анализ затрат на технологию и то, как она может окупиться в будущем.

Ключевые слова: платонинг, совместная система движения, автоматизация дорог, связь между транспортными средствами

Для цитирования: Малышева Т. Автоматизация логистического процесса с использованием технологии платонинга для перевозки грузов из Финляндии в Санкт-Петербург // Техноэкономика. 2022. Т. 1, № 1. С. 43–53. DOI: https://doi.org/10.57809/2022.1.1.4

Introduction

The world we live in is changing dramatically through innovation, and the pace of change is accelerating every day. Whether it be social, economic or environmental factors, innovators are taking a hard look at the industry's biggest challenges to develop ways to solve them. According to the European Union, three-quarters of domestic freight traffic is transported by road (Nowakowska-Grunt and Strzelczyk, 2019). That amounts to about 1,750 billion ton-kilometres (TBM) of freight. As a result, fuel consumption, CO_2 emissions, traffic congestion, and traffic safety have been significantly affected. To alleviate these problems in the transportation industry, innovations such as platooning and autonomous vehicles have been developed (Bergenhem et al., n.d.).

Truck platooning is the linking of multiple trucks in a convoy using communication and sensors between vehicles (Fan et al., 2018; Zhang et al., 2020). Virtual communication between trucks allows the vehicles to automatically accelerate, brake, and follow each other at closer distances than would normally be possible with unconnected trucks. Platooning can be defined differently by different projects because there are different goals and motivations for platooning, as well as different technical solutions. However, in order for such convoys to be deployed, the behaviour of these vehicles in the convoy must be verified.

There are 5 levels of vehicle autonomy (Fig. 1), and in this paper, I will look in more detail at the third level, since it is currently the most appropriate and its implementation seems the most realistic, given the legislation, the quality of the routes and so on.

The third level, the Advanced Driving System (ADS) can perform and control all required driving functions in some conditions. However, when the ADS receives a warning, the driver must be able to

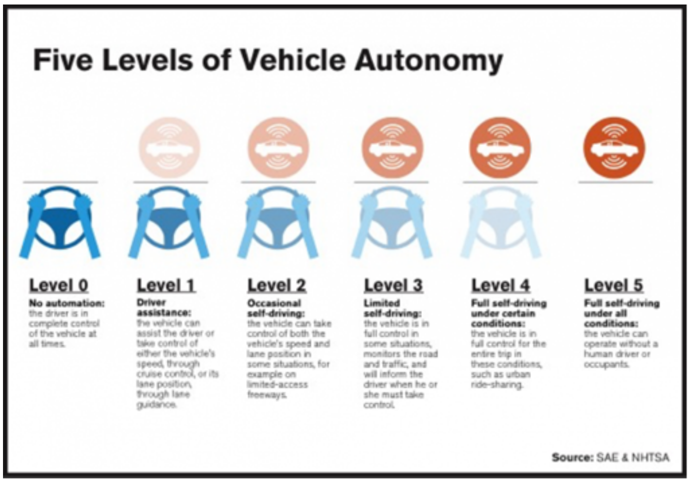

Fig. 1. Levels of Vehicle Autonomy

take over control. In addition, the remaining critical tasks must be performed by the driver (Stehbeck, 2019).

This study aims to explore methods to improve the process of delivery of goods from Finland to St. Petersburg and other nearby cities, by truck platooning.

Materials and Methods

When writing this article, an analysis of the existing literature on the topic of platooning, the principles of the technology, as well as the existing use cases were studied. Also, in order to adapt the use of technology to a specific route and country, the current state of the route was studied, as well as average prices for components and consumables. All calculations were carried out using Microsoft Excel. Also, the documents of the companies-suppliers of trucks using platooning technology, which are open to access, were studied.

Results and Discussion

The freight industry is heavily filled with trends such as digitalization, automation, communications, and electrification. These trends are restructuring the value network of the freight industry by creating new ways of doing business. Through connectivity and data mining, vehicle data can be aggregated and processed to produce data insights that benefit the supply chain. This opens new opportunities for logistics companies to provide new digital, data-driven services beyond their traditional business model (Larsson et al., 2015).

In the long term, leading companies aim to offer logistics as a service with autonomous vehicles directly to shippers by partnering with a digital logistics broker. To achieve this, four major service systems have been developed incrementally and linked with other technologies:

1. Connectivity and data sharing: providing a visible and controlled transportation operation for both carriers and shippers through seamless data orchestration and sharing.
2. Optimize transportation operations: provide sustainable and efficient logistics and transportation management services to customers through data-driven decision making and integration of digital logistics brokerage platforms.
3. Accelerating the EV transition: accelerating the transition to electrified vehicles by providing customers with an easy transportation experience through intelligent routing and charging services.
4. Logistics as a service with autonomous vehicles: transforming towards providing a transportation ecosystem by providing logistics as a service with autonomous vehicles (Chi, 2020).

Platooning technology can allow vehicles to move completely autonomously. In Russia, the use of autonomous transport is currently extremely underdeveloped. But attempts are already beginning to introduce it. For example, the movement of semi-autonomous trucks has been tested along the Moscow-Kazan route. Even the use of technology on the 3rd level benefits both business and society. The benefits will be discussed in more detail in the following sections.

The context of the chosen logistics process.

One of Russia's major trading partners is Finland. Active cargo transportation of products is carried out in both directions. This is not surprising, since the border of the country is located at a distance of just over 1000 km from St. Petersburg. Road, rail, sea and air transport is used for transportation. The fastest and least expensive is road, namely transportation by truck.

The main road junction between St. Petersburg and Helsinki is the E-18 highway (Fig. 2). Highway E18 is a highway of national importance. The increased ties between the EU and Russia, as well as the processes of European integration, predetermined in due time the construction and development of E18. The importance of the highway is that it connects the capitals of Norway, Sweden and Finland with St. Petersburg. The result is an international transport highway between the European Union and Russia. At the moment, repair work is being carried out on a stretch of highway located in the Leningrad region, which is scheduled to be completed by the end of 2023.

A huge amount of time trucks can stand in traffic jams at the border while waiting for cargo clearance. In addition, there is a limited amount of time that, according to the law, a driver can drive a vehicle.

In addition, road repairs slow down the process of transporting goods, as drivers travel a shorter distance because of the lower speed, while the downtime of the truck and the driver increases. This article will look at how autonomous vehicle technology can optimize the process of shipping cargo from Finland to Russia.

The transport process is central to the delivery process. For the most part, it covers the operational level. But looking at the process from a tactical level, transport company managers need to ensure that downtime of company resources is kept to a minimum. According to Russian law, a driver can only drive a truck for 4.5 hours continuously. And a total of 9 hours a day a driver can be at the wheel, thereby creating downtime for the truck. This is the root cause of the downtime problems for vehicles and drivers.

In addition to this, the driver is in the truck while resting. Especially in winter, a huge amount of fuel is wasted warming up the cab. Fuel is also consumed to charge the accumulator so that there is light in the cab at night. All these nuances cannot be circumvented by traditional methods, because rest periods

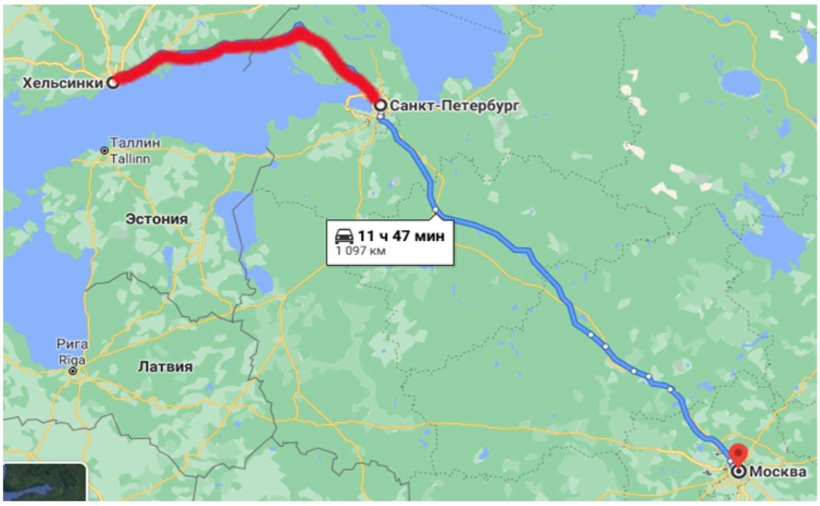

Fig. 2. The Route St. Petersburg – Helsinki

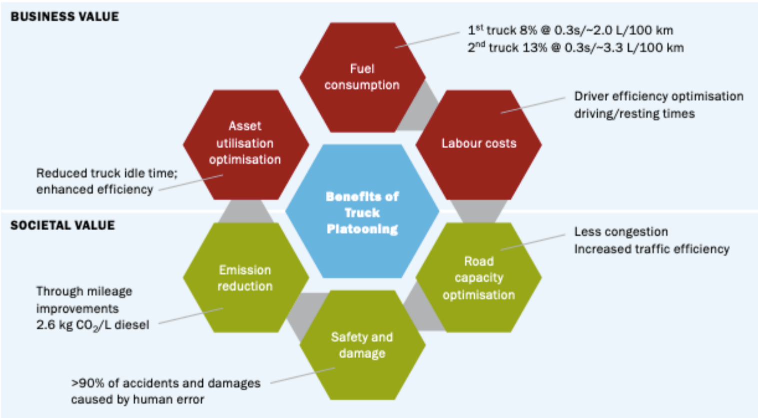

Fig. 3. Benefits of platooning technology (Source: (Boysen et al., 2018))

are legally stipulated. All of these problems can be solved by introducing pay-as-you-go technology, and the next section will describe in more detail how this can be achieved (Alam et al., 2010).

How the logistics process can be improved.

Based on an analysis, the process therefore needs to be optimized so that drivers can rest while driving. There are two solutions. First one – 2 drivers in one truck, which is also inefficient because for the same amount of time, the number of services performed would be half as much, and the second one – introduction of platooning technology.

When there are two drivers per platoon, the driver of the Following Vehicle can rest while at the same time being productive as his truck is still driving (the plausibility of this assumption depends on the law and implementation phase). When the trucks and their drivers switch places every now and then – the Following Vehicle becomes the Leading Vehicle and vice versa-, the resting times can be reduced compared to the benchmark situation.

In addition, the technology also has other benefits which are shown in the Fig. 3. Connecting trucks has great potential to reduce transport costs, improve road safety, prevent traffic congestion, and improve cleanliness and efficiency. In some EU countries, 90% of total freight is transported by road and 25% of truck fuel consumption is caused by air resistance (Tsugawa et al., 2016). This has a significant impact on CO_2 emissions, congestion and fuel consumption. The technology reduces transport costs through improved aerodynamics, thus eliminating the need for an attentive driver in a second vehicle. In other words, as the trucks travel at a constant speed within 0.3 seconds of each other, fuel consumption will be reduced as braking and acceleration are autonomously controlled by the system (Santini et al., 2017). Furthermore, 90% of all road accidents are caused by human error. Thanks to this innovative technology, human errors are prevented during convoy driving, which implies fewer accidents and damage. In addition, congestion will be prevented with Platooning, as truck lengths will be reduced due to a gap of 0.3 seconds, which means that road capacity is optimized.

To use the technology more effectively, platforms are created where carriers share their data with other companies in order to find other truck and form a convoy with them. For example, trucks arriving from Moscow and departing from St. Petersburg can form a platoon and travel together (Chen et al., 2020).

Now it is already possible to actively test the technology on some highways in Russia. As, for example, on the new M-11 highway connecting Moscow and St. Petersburg which has also recently been opened. And upon completion of the repair work, it will be possible to organize joint convoys of trucks coming from Moscow and departing from St. Petersburg.

The description of the to be applied technology

To guarantee a coordinated motion of the vehicles in the platoon, cooperative adaptive cruise control (CACC) algorithms are used to compute the acceleration of each vehicle based on on-board measure-

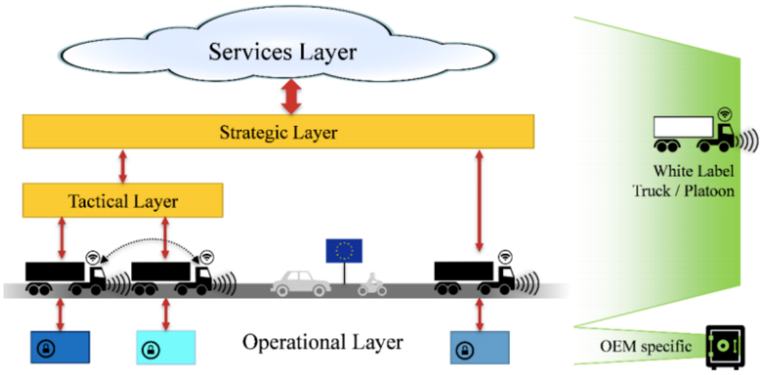

Fig. 4. Platooning layers (Source: (Konstantinopoulou et al., 2019))

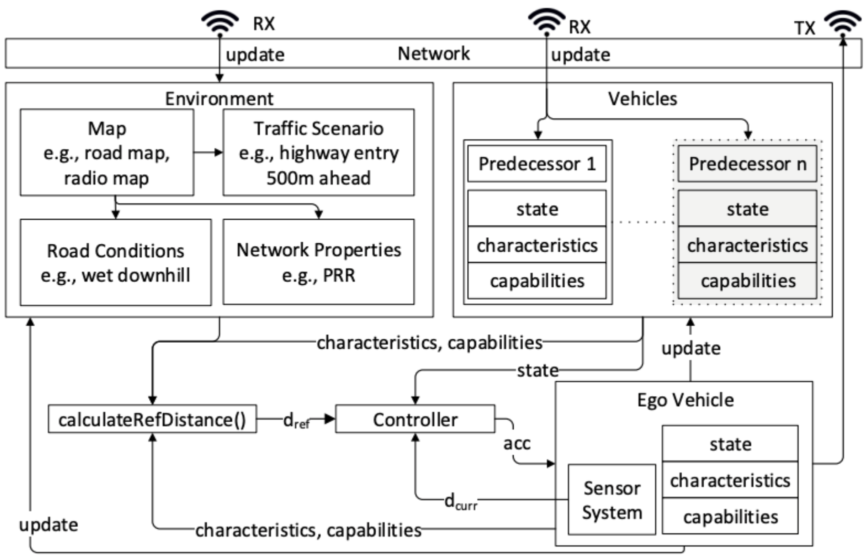

Fig. 5. Following the reference distance (Source: (Renzler et al., 2019))

ments and information gathered from the other platoon members through Vehicle-to-Vehicle (V2V) communication systems ("Cooperative Adaptive Cruise Control (CACC) for Truck Platooning: Operational Concept Alternatives," n.d.). The building blocks of cargo movement in a caravan consist of in-vehicle requirements (longitudinal, sensors, HMI-interface interaction), infrastructure (zone policy), information (starting, V2V and V2I exchange, and data exchange), and movement in a caravan strategy at the tactical level (coordination mode, break formation, dissolve, and mix vehicle) (Lakshmanan et al., 2019).

The tactical layer coordinates the actual formation of the platoon (both from the tail of the platoon and by merging in the platoon) and the disbanding of the platoon.

The tactical level shares information about the state of the vehicle equally within the platoon, as well as the state of the platoon. The setpoint limit / recommendation function will send to the operational level a combined recommended value for a given vehicle speed and time interval, processed based on information from the strategic level and platoon status. The requirements modeling process is supported by first principles modeling in order to perform a reality check on the feasibility and relevance of specifications (Konstantinopoulou et al., 2019).

Miles per tractor per year		110 000	Input fleet data
% of the miles platooning		75%	Input %
Miles per tractor platooning		82 500	Calculated
<u>Costs</u>			
Total Installed Cost			
Collision Avoidance Technology	$	1 500	Input $0 if already in tractor spec
Adaptive Cruise Control	$	250	Input $0 if already in tractor spec
V2V Radios for Transmission	$	250	Input your own data
In-Cab Cameras	$	200	Input your own data
Other material or tech update during ownership	$	400	Input your own data
Labor to install	$	200	Input your own data
Total Installed Cost	**$**	**2 800**	**Calculated**
Other Costs			
Any per truck cost (Annual subscription, etc.)	$	200,00	Input cost per truck per year
Additional maintenance costs per truck per year	$	50,00	Input cost per truck per year
Other ongoing costs?			
Driver and technician training	$	50,00	Input cost per truck per year
Incentivize drivers to platooning ($/mile)	$	0,0075	Incentive per mile if any
Annual Driver Incentive	$	618,75	Calculates annual incentive
Total Annualized Costs	**$**	**918,75**	**Calculated**
<u>Benefits</u>			
Fuel Savings			
Fuel miles per gallon		7,00	Input fleet data
Fuel $ per gallon	$	3,00	Input fleet data
Fuel Expense per mile per truck	$	0,43	Calculated
Total Fuel Expense per year per truck before platooning	$	47 142,86	Calculated
% of platooning miles following		50%	Input fleet data
Estimated % fuel savings following		7,5%	Input fleet data
Fuel expense saved following	$	1 325,89	Calculated
% of platooning miles in the lead		50%	Input fleet data
Estimated % fuel savings while in the lead		3%	Input fleet data
Fuel expense saved in the lead	$	530,36	Calculated
Fuel savings per year per truck	**$**	**1 856,25**	**Calculated**
Repair and insurance costs	**$**	**500,00**	**Zero if already assumed with**
Other Benefits?			**safety equipment**
Total of one time costs	**$**	**2 800,00**	**Calculated**
Total of annualized costs	**$**	**918,75**	**Calculated**
Total of annualized savings	**$**	**2 356,25**	**Calculated**
Payback in months		**23,4**	**Calculated**

Fig. 6. Cost benefit analysis

To ensure interaction with the trucks in the platoon, communication must be established between the platoon members. A decentralized tactical layer running locally in trucks needs information from other trucks (Fig. 4). Requirements for vehicle hardware components specific to platonizing can be grouped into the following categories:

– HMI-driver-vehicle interface and, in particular, the platooning solution

– Longitudinal control system consists of sensors, control computing and communication-control executive components.

The trucks in the platoon try to maintain a predetermined distance to the predecessor. The distance is usually the same for all vehicles in the platoon and is selected to meet certain requirements. Vehicles measure the distance to their predecessor and receive additional V2V communication information from their predecessor (such as acceleration and speed). In connection with driving vehicles, they operate under constantly changing conditions (different road scenarios), and external influences can lead to different environmental conditions (for example, weather, traffic density) (Hjälmdahl et al., 2017).

Network Properties: Only a highly reliable network provides a close inter-transport distance. Relying on cellular networks, latency, data rate, and coverage area vary depending on the current location and data traffic. Low data transfer rates and high latency due to poor coverage are known from radio cards. There, vehicles can plan to increase the distance or prepare the transition to a special network. In ad-hoc networks, reliability mainly depends on the number of transmitting nodes and the load on the network (Hameed Mir and Filali, 2014). Knowing the current reliability of the underlying network allows to update the reference distance.

Fig. 5 summarizes all external influences that contribute to the determination of the reference distance. The following figure shows that cars are constantly updating their vision of the environment: the properties and capabilities of cars are exchanged using CAM, and the distance is measured by the onboard sensor system. Information about network properties, traffic scenarios and road conditions are provided using maps, analyzed by the vehicle itself using cameras and sensors, or received via a communication channel (Renzler et al., 2019).

Cost calculations

There are various costs associated with the implementation of platooning. The table below (Fig. 6) contains the costs of the technology and how it may pay for itself in the future. All prices are notional, as it is not possible to accurately calculate the number of sensors, cameras and other equipment, the price of fuel, as it is constantly changing (Calvert et al., 2019).

Based on the calculations, it can be concluded that the introduction of such technology will pay for itself fairly quickly. Moreover, it will save money, in addition to all the other benefits mentioned above.

Conclusions

In this article, the process of cargo transportation from Finland to Russia was analyzed, difficulties and problems were identified, and as a result how this process can be optimized was realized. The best solution is to organize movement of trucks in a convoy. Connecting trucks has great potential to reduce transport costs, improve road safety, prevent traffic congestion, and improve cleanliness and efficiency.

According to Russian law, a driver can only drive a truck for 4.5 hours continuously. And a total of 9 hours a day a driver can be at the wheel, thereby creating downtime for the truck. This is the root cause of the downtime problems for vehicles and drivers. With platooning, when there are two drivers per platoon, the driver of the Following Vehicle can rest while at the same time being productive as his truck is still driving (the plausibility of this assumption depends on the law and implementation phase).

In section 6, the principle of operation was described in more detail, as well as the systems that ensure the operation of the technology. Of course, only the basics were described, for a more in-depth study it is necessary to devote an entire article. Then the economic efficiency of the system implementation was calculated, which showed that the system will pay off quickly enough.

Summing up, such technologies need to be implemented in the processes of Russian companies. The main problem is the roads, because in order for the column to be convenient to overtake other road users, it is necessary to have at least two lanes in one direction, which is not always the case. Scania had already planned to conduct a test trip from St. Petersburg to Finland, but due to restrictions, the experiment was not completed.

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Статья поступила в редакцию 15.12.2021; одобрена после рецензирования 17.02.2022; принята к публикации 01.03.2022.

The article was submitted 15.12.2021; approved after reviewing 17.02.2022; accepted for publication 01.03.2022.

Technoeconomics. 2022, Vol. 1, No. 1. Pp. 54–64.
Техноэкономика. 2022, Том 1, № 1. С. 54–64.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2022.1.1.5

ANALYSIS OF POSSIBILITIES OF BUSINESS ANALYTICS SYSTEMS FOR HEALTHCARE

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Abstract. Rapid development of information technologies determines the need in usage of various digital solutions in order to conduct operational analysis and processing of large amounts of information. In today's age, the introduction of digital solutions is especially relevant in the healthcare system. The development of conditions for such analysis of information is one of the main tasks of digitalization of the healthcare system. Nowadays, there is no significant experience in conducting digital data analysis in the field of healthcare. Because of that, it is highly beneficial to study the experience of various non-medical organizations in this field, including the ones that effectively use Business Intelligence technologies for such tasks. Thus, this article explores data storage and analysis tools, as well as the market of existing BI-systems and the specifics of the application of these systems in the healthcare sector are examined.

Keywords: business intelligence, healthcare, business analytics, digital technologies, data analysis

Citation: Dubgorn A., Esser M. Analysis of possibilities of business analytics systems for healthcare. Technoeconomics. 2022. 1 (1). 54–64. DOI: https://doi.org/10.57809/2022.1.1.5

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2022.1.1.5

АНАЛИЗ ВОЗМОЖНОСТЕЙ СИСТЕМ БИЗНЕС-АНАЛИТИКИ В СФЕРЕ ЗДРАВООХРАНЕНИЯ

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Аннотация. Стремительное развитие информационных технологий определяет необходимость использования различных цифровых решений для оперативного анализа и обработки больших объемов информации. В современный век внедрение цифровых решений особенно актуально в системе здравоохранения. Создание условий для такого анализа информации является одной из основных задач цифровизации системы здравоохранения. В настоящее время отсутствует значительный опыт проведения анализа цифровых данных в сфере здравоохранения. В связи с этим весьма полезно изучить опыт различных немедицинских организаций в этой сфере, в том числе эффективно использующих технологии Business Intelligence для решения подобных задач. Таким образом, в данной статье исследуются средства хранения и анализа данных, а также рассматривается рынок существующих BI-систем и особенности применения этих систем в сфере здравоохранения.

Ключевые слова: бизнес-аналитика, здравоохранение, бизнес-аналитика, цифровые технологии, анализ данных

Для цитирования: Дубгорн А.С., Эссер М. Анализ возможностей систем бизнес-аналитики в сфере здравоохранения // Техноэкономика. 2022. Т. 1, № 1. С. 54–64. DOI: https://doi.org/10.57809/2022.1.1.5

Introduction

Nowadays, the Russian Federation has adopted and is implementing the federal project "Digital Technologies", which is a part of the state program "Digital Economy of the Russian Federation" (until 2024), as well as the state program "Development of Health Care" (until 2020) ("The main directions of budgetary, tax and customs-tariff policy for 2019 and for the planning period of 2020 and 2021 (approved by the Ministry of Finance of Russia)," n.d.). These programs determine the development and digital transformation of priority sectors of the economy based on end-to-end digital technologies.

Main goals of the Digital Technology project are following:

– "providing support to the leading high-tech companies on the Russian market, the ones developing products, services and platform solutions based on end-to-end digital technologies aimed at digital transformation of priority sectors of the economy and social sphere, with focus on domestic developments";

– "providing support for projects aimed at scaling technological solutions based on "end-to-end" digital technologies used in priority sectors of the economy and social sphere" (*Decree of the President of the Russian Federation of 05/07/2018 No. 204 "On national goals and strategic objectives of the development of the Russian Federation until 2024*," n.d.).

Implementation of a unified state healthcare information system provides a solid basis for the creation of a system intended to collect and sort indicators of regional healthcare systems. However, it is necessary to develop the means of effective support in managerial decision-making in the healthcare sector both at the level of individual medical organizations and at the regional and country-wide levels ("Thirteenth General Programme of Work 2019–2023," n.d.). Business Intelligence (BI) systems provide said means of effective support in managerial decision-making and present an ideal tool for the health indicators analysis of Russia's federal subjects. One of the main advantages of such systems is the ability to create visual tools for making both strategic and operational decisions at various levels of the medical structures.

This article explores the concept of the term Business Intelligence from the point of view of various authors and research organizations, highlights the key features of Business Intelligence, and also presents the advantages and disadvantages of using Business Intelligence technology. In addition to that, the article discusses data storage and analysis tools and examines the market of existing BI-systems and the specifics of the application of these systems in the healthcare sector.

Materials and methods

The rapid development of technologies, including the ones used in the healthcare system, determines the need for the usage of various IT-solutions for conducting multi-aspect operational analysis of the available information.

One of the main goals of digitalization of the healthcare system is the development of proper conditions required for such analysis. Active implementation of the National Healthcare Project and the "Creating a Unified Digital Circuit Based on EHISS" Federal Project allows to create a convenient environment for analytics but the current level of experience of medical staff and executive authorities in the healthcare sector highlights the lack of ready-made, well-established IT-solutions and significant experience in conducting digital data analysis ("Federal project 'Creation of a unified digital circuit in health care based on a unified state information system in health care (EGISZ),'" n.d.; "National projects 'Healthcare' and 'Demography,'" n.d.).

Consequently, it is highly beneficial to study the experience in the field of data analysis and the creation of proper conditions for decision-making in organizations of various non-medical areas of activity. Most organizations effectively use Business Intelligence (BI) technologies to solve such problems.

The term Business Intelligence was first used by Hans Peter Lun in 1958 in the article "A Business Intelligence System", published in IBM System Journal. The author divided this term into components and characterized them separately. Lun described Business as a set of various activities undertaken in science, technology, commerce, industry, legislative activity, defense, etc. Various communication systems that provided and supported these types of activities he called "intelligence system". In general, term "intelligence" Lun defined as the ability to establish a relationship between the representations of individual facts in order to better solve the goals and objectives.

Late in the 1980s, Gartner analysts under the leadership of Howard Dresner gave a broader definition of the term – "user-oriented process, which allows access and research of information, its analysis, development of an understanding, which, in turn, leads to improved and informed decision-making". Later in 1996, Dresner added the following to the definition: "Business Intelligence is a tool for analyzing data, creating reports and queries that can help business users to overcome the large quantities of data in order to synthesize meaningful information from it" (Iliashenko et al., 2017).

There are other interpretations of this term. The Data Warehousin Institute, an organization that studies the analysis and storage of data, gives the following definition: "Business intelligence allows to turn data into knowledge, and then that knowledge is used to formulate business actions ensuring profit." Forrester Research defines Business Intelligence as "a set of methodologies, processes, architectures and technologies for processing primary data into meaningful and useful information used by management teams to better understand business processes and make informed decisions at the strategic, tactical and operational levels" (I. Ilin et al., 2018).

So, despite slight differences in definitions, a number of common attributes of Business Intelligence can be distinguished. Today BI-solutions are not only used for to conduct analytics and form reports, but also for data collection and quality management.

Based on previous statements, it can be concluded that business analytics, in the broad sense of the word, means:

1. The process of turning data into information and knowledge about the business in order to ensure improved decision-making;
2. Information technologies, methods and tools for data collection and information consolidation;
3. Business knowledge gained from in-depth data analysis.

The presented technology is based on the principles of end-user access to the analysis of structured data. This creates an integration process, allows end users to interprete transactional business information in the most simple, understandable way suitable to be the basis for business analysis and development of an effective strategy for changing the organization. Business Intelligence has a wide range of users, including both ordinary employees, as well as analysts and managers at various levels. In relation to medical organizations, it should be noted that Business Intelligence technologies are of interest both to doctors of various departments, as well as to heads of departments, statisticians and heads of organization ("Sustainable Development Goals," n.d.).

Nowadays, the categories of BI-products are usually divided into: BI-tools and BI-applications. BI-tools, in turn, are classified into the following types (Iliashenko et al., 2017):

1. Query and report generators – desktop tools that provide users with access to databases, perform analysis and generate reports;
2. Developed BI-tools (most impotantly, OLAP analytical processing tools);
3. Enterprise BI Sets (EBIS) – a set of BI-tools that were previously presented as separate products;
4. BI-platforms – sets of tools for creating, implementing, supporting and maintaining BI-applications.

Given the diversity of various types of BI-solutions used for working with typical tasks, it is easier to talk about the typical blocks of modern BI-systems. The main capabilities of Business Intelligence systems are focused in the following directions: storage, integration, analysis and presentation of data.

Data storage

To store the data used by BI-systems throuout their work, special storages called data warehouse are organized. The stored information should present a valid, real and comprehensive view of the organization because of that the data is collected from various operating systems. For a more efficient analysis, the data storage structure is formed in a way most suited for creating and processing various requests, while in ordinary databases, optimization of the execution time of transactions is often more important.

It should be noted that if the data size is too large, specific subsets of information can be formed, called data marts, in order to solve narrow, specific tasks.

There are several different approaches to data integration. The so-called data warehouse management tools, ETL tools, are used to form and maintain the data warehouse. The ETL abbreviation itself stands for Extract, Transform, Load, which is a brief description of the function of these tools. Thus, ETL tools are tools that allow to extract, transform and convert data to a specific required format. These tools are used for uploading data to the repository or another database.

Alongside ETL tools, BI-systems include tools that allow to wotk with a programming language used to manage real-life databases in database management systems (DBMS). One of the most common ones is the Microsoft DBMS – SQL Server. The abbreviation "SQL" stands for structured query language, which means that is allows users to directly access the data.

It should be noted that recently the tools for generating and processing requests have become more geared towards unprepared users, rather than on qualified IT specialists (Ilin et al., 2017).

Data analysis and visualization

Modern BI systems cannot be imagined without using OLAP (Online Analytical Processing) technologies for data analysis. This technology involves the acceleration of the processing speed of large data arrays by structuring information according to a multidimensional principle. Storing information in separate database tables often leads to an increase in the complexity of processing multi-table queries. Because of this an OLAP structure of joining tables in the "star pattern" or "snowflake pattern" is currently used in BI systems.

The presented tools allow to quickly generate the required data slices, and then visualize the given information in a numder of different ways such as graphs, charts, reports, all customizable according to various parameters. Using the OLAP structure allows to quickly make changes to the presented data (Ilin et al., 2017).

It should also be noted that a number of the most developed BI-solutions support the data mining technology. This usually means as a group of tools designed to facilitate the search for hidden, unknown and non-trivial patterns. This group of tools includes various modeling and forecasting methods based on neural networks, the decision tree, Bayesian networks, regression and correlation analysis, and various other methods. Data mining technologies are designed to facilitate the analysis of huge amounts of information, as well as to ensure the competence of strategic decision-making by using the analysis of various event scenarios.

Dashboards and scorecards are the most widespread and generally accepted means of displaying data in modern BI-systems. Information panels are visual solutions on which the main parameters are displayed in the form of charts, scales and indicators. These tools allow users to both evaluate and monitor the current values of the parameters, as well as making the comparisons with the various values of the indicator and, as a result, identifying the existing risks and threats.

Scorecards are a visual solution directly related to the analysis of key indicators (KPI – key performance indicator). In this case, we are talking about a comparison with the target indicator values. These cards are the simplest and most convenient form of studying and preventing the risk of not achieving the planned values of indicators (Ilin et al., 2019).

Benefits of using Business Intelligence Technology

The usage of BI-systems makes it possible to solve a very wide range of tasks, including monitoring and analysis of the current values of indicators, as well as determining strategic and operational goals of the organization's development. Among the advantages of using BI-systems there are:

1. creation of a support system for the development of existing business processes and structural changes in the organization;
2. the emergence of opportunities for modeling business cases;
3. creation of conditions for operational analysis and work with non-standard query forms;
4. redirection of human resources from routine analytical activities and filling out reporting documentation to deeper analytical work;
5. the growth in the volume of processed and analyzed information due to the possibility of scaling the system.

Also, the use of BI-solutions provides some additional opportunities in the field of strategic development. They include (Iliashenko et al., 2017):

1. evaluation of the effectiveness of various activities;
2. operational and continuous monitoring of the attainability of key goals and objectives;
3. the formation of a method for assessing the effectiveness of the use of available resources;
4. calculation of the effectiveness of financial activities;
5. cost and investment management.

According to experts from MiPro Consulting, the use of a BI-system in the organization has a number of significant advantages compared to the use of standard analytical tools integrated into the organization's existing information systems. These benefits include:

1. improving the visibility and increasing the convenience of working with data;
2. the possibility of using several analytical solutions, depending on the nature of the problem and the direction of activity of a particular unit of the organization;
3. the ability to work with various data sources and data types;
4. continuous development and improvement of existing BI-platforms;
5. high level of scalability, performance and efficiency of the analysis of indicators;
6. the emergence of conditions for building and supporting end-to-end procedures throughout the organization;
7. the possibility of creating analytical centers responsible for studying information about the organization's activities;
8. variety and flexibility of analytical tools for solving tasks;
9. the ability to provide users with data and analytical tools in accordance with their access rights.

It is important to note that the use of analytical tools integrated into the other information systems that are not directly intended for analytical activities usually has a number of limitations:

1. the lack of differentiation of user access rights to analytical tools;
2. extremely limited set of analytical tools;
3. the necessity to export and analyze data in other software products, for example, in the Microsoft Office Excel package because of disadvantages of the built-in tools for visualization and analysis of the information;
4. inability to work with external data sources is not available;
5. the limit on the number of users using the analytical extension of the information system, due to the fact that the widespread use of this product can significantly impair the work of the application for other employees of the organization;
6. limitations on the formation of flexible, non-standard queries;
7. the use of large amounts of historical information is limited (I. V. Ilin et al., 2018).

Disadvantages of using Business Intelligence Technology

In practice, in the process of forming a BI solution, the first task is to organize a scheme for collecting information and creating a unified database of the organization as the main information space of the institution. The storage of the BI-system should provide for the possibility of the receipt of information from any available, including external sources. In reality, the tasks of implementing an immediate solution fade compared with the tasks of creating a integrated digital space within the organization.

Standard reports are only a small part of the capabilities of BI-systems. These solutions have significant potential for creating a powerful analytical tool that will provide an opportunity to analyze all the activities of the company. And it does not even require the implementation of new independent programs to solve individual problems. However, the presented positive side carries a number of disadvantages. BI-systems are tools built on rapidly changing technologies. Significant pace of development and improvement of existing solutions require constant monitoring of existing BI-systems.

Another important risk of the practical use of BI-systems is the performance degradation with insufficient data quality. If the data are not properly processed and cleared, then none of the possible BI-tools will not achieve significant results in the analysis of information. This situation is not always clearly presented to the main stakeholders, and BI-solutions are often associated with inefficient work of the analytical group, and not with problems with the data collection structure. BI-technology itself is not able to comprehensively solve these problems, and neglect of them returns to information anarchy (Iliashenko et al., 2017).

Results

Market overview of existing BI-systems

According to Gartner, in 2018, the explosive development of the business analytics industry was recorded, which was largely due to the development of machine learning technologies and neural networks. Today, there is every reason to argue that the trend of increasing influence of the new generation BI-platforms continues.

Gartner analysts urge suppliers of all BI-systems to pay attention to the realities of the information space and radically revise their point of view on working with data: BI-systems can no longer rely on standard data mining methods. The rest of the technology world is moving to bring machine learning, NLP and AI to customers, so BI-industry must do the same.

One of the easiest ways to form an idea of market leaders is to present the magic square of market leaders used by the Gartner analytical agency. So, at the beginning of 2018, there are three main leaders on the market: Qlik, Tableu and Microsoft with its Power BI solution.

Market overview of BI-systems in healthcare

According to Marketsand Markets, the global healthcare BI market amounted to about $ 2.38 billion in 2013. And in 2019, it is expected to reach $ 4.74 billion (average annual growth of 14.8%). In the medical market, technology is dominated by traditional Business Intelligence, while cloud-based BI and mobile BI represent great potential for growth: on the one hand, hospitals, in the face of limited economic resources, need more accessible, flexible, transformable and scalable forms of business intelligence, and on the other hand, the demand of medical institutions for mobile solutions is growing (“Transforming our World,” n.d.).

The further market growth can go mainly due to the implementation of BI solutions directly in medical organizations. However, it should be noted the importance of using BI systems in executive bodies in the field of healthcare management.

There are a lot of vendors of analytical solutions in the healthcare sector. Among them, the largest include IBM, Information Builders, Microsoft, MicroStrategy, Oracle, Qlik Technologies, SAP, SAS, TIBCO Software, Tableau Software, Computer Sciences Corporation, Dimensional Insight, Jaspersoft, Klipfolio, Perficient, Agilum Healthcare Intelligence, Siemens Healthcare, Tata Consultancy Services, Infosys, Wipro Limited, Hexaware Technologies Limited and others (Mackenbach and McKee, 2013).

Let's take a closer look at the solutions that are recognized as market leaders.

1. *QlikView from Qlik company*

This platform focuses on the needs of the user as the ultimate recipient of data. There is a high flexibility to study and visualize data, as well as the presence of a relationship between the data and the dip function, which allows obtaining detailed information about each studied parameter. Key product features are (Troyansky et al., 2015):

1. opportunities to create advanced dashboards based on data from a variety of sources;
2. the presence of a tool for automatic recognition of relationships between data, which can significantly simplify the work of the end user in the process of creating reports and dashboards;
3. data storage in the server RAM, which speeds up the process of query execution when working with a large data array;
4. QlikView reports and dashboards have a low entry threshold, which allows even beginners to use these functions. However, the process of creating dashboards itself requires advanced development and SQL skills, as well as the presence of certain practices in the QlikView programming language.

It should be noted that when using QlikView, the main thing is a clear understanding of current goals and objectives, as well as a vision of the final result. This solution allows to demonstrate amazing results with a clear consistent course and its implementation.

2. *Tableau*

As a BI solution, Tableau's main focus is the presentation of data through visualization. The system makes it easy to create interactive dashboards, with a dip function and transitions to trend indicators. It should be noted the wide possibilities of the visual library, which includes word clouds, bubble and tree diagrams, and other tools (Nair et al., 2016). Also there is a function of combining elements, which allows you to reduce and overlap various visual solutions, which is especially important in view of the need to save work space in the monitor space.

The main difference between this solution and competitors is the ability to mix data from different databases and sources, as well as the ability to work with a significant number of different types of data.

It should also be noted that the functionality of the program allows simultaneous use by several users in real time.

It is important to note that Tableau is relatively loyal to beginners who were not previously interested in data visualization issues. There is an intuitive interface, well-described technical guidance and assistance. It is convenient to work with the program both from the side of the user creating the report, and from the end-user studying the result and making strategic decisions.

3. *Power BI by Microsoft*

A service developed by Microsoft as an extension of the existing functionality of Microsoft Office Excel. The solution is characterized by a relatively simple and intuitive interface, as well as the presence of many functions similar to the apparatus of the latest version of Microsoft Office Excel. In addition, the system is as friendly and compatible with another development of Microsoft – the SQL Server hardware product (Ferrari and Russo, 2016).

However, it should be noted that there are certain limitations in the examples of data visualization, and the program also notes a relatively small number of tools for cleaning and processing data (Mackenbach and McKee, 2013).

The specifics of BI-systems in healthcare

It should be noted that the use of Business Intelligence technologies in healthcare has a number of features.

Medical organizations operate with various layers of data: personal information about patients, test results, radiological and computer images, video recordings of studies, as well as information from management systems and others. For quick and timely decision-making in the presence of such an array of data, careful collection and analysis of information is necessary. Automation of medical analytics requires taking this feature into account (Ritsatakis et al., 2009).

It is also important to remember that medical activity is associated with the concept of medical confidentiality. So, according to Article 13 of the Federal Law of November 21, 2011 No. 323-FL (as amended on May 29, 2019) "On the Basics of Protecting the Health of Citizens in the Russian Federation" ("United Nations Millennium Development Goals," n.d.) information about a citizen's appeal for medical assistance, his state of health and diagnosis, or other information obtained during his medical examination and treatment, constitutes medical confidentiality and it is not allowed to disclose information constituting medical confidentiality, with the exception of cases established by parts 3 and 4 of this article. It should also be noted that there is a significant amount of depersonalized data that is not a medical confidentiality, but has a limited level of access, since its wide dissemination can influence on the security of the Russian Federation ("Federal project 'Development of a network of national medical research centers and the introduction of innovative medical technologies,'" n.d.).

An essential feature of medical organizations is that usually two types of BI are required by healthcare institutions. Firstly, this is analytics aimed at supporting the healing process, and secondly, managerial analytics. These two systems solve different problems, determined during the treatment process at various levels and practically do not intersect. It should also be noted that organizations responsible for studying existing health systems can be is interested in a separate type of management analytics (World Health Organization, n.d.).

Conclusions

The quality of decisions made by the management of medical organizations and state bodies of the healthcare system depends on the corresponding information support, which is directly related to BI-systems. Today, BI technology allows to better understand the structure of medical care and increase the speed of informed decisions. BI is not only a business analysis of information, but also work with big data from different sources, their processing, testing, presentation and servicing of requests for this information. It is important to automate the processing of information, because it will reduce the time to perform routine operations and receive relevant quality information.

The article discusses market leaders. It is a QlikView platform that focuses on the needs of the user as the ultimate recipient of data. The platform has high flexibility to study and visualize data, as well as the presence of a relationship between data and a dip function. The Tableau system is characterized by the presentation of data through visualization and the ability to work with a significant number of different types of data. Power BI service is characterized by a relatively simple and intuitive interface, as well as the presence of many features similar to the apparatus of the latest version of Microsoft Office Excel.

The article also considered a number of features in the healthcare system when using Business Intelligence technologies. Thus, medical organizations work with large amounts of data, which require careful collection and analysis of information presented in the form of reports and forecast models. Often, such data is the personal information of patients and is not subject to disclosure. An essential feature of medical organizations is that healthcare institutions require two types of BI – analytics aimed at supporting the treatment process, and managerial analytics. These two systems solve different problems that are determined during the treatment process at different levels and practically do not intersect.

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Статья поступила в редакцию 21.10.2021; одобрена после рецензирования 24.11.2021; принята к публикации 27.11.2021.

The article was submitted 21.10.2021; approved after reviewing 24.11.2021; accepted for publication 27.11.2021.

Technoeconomics. 2022, Vol. 1, No. 1. Pp. 65–74.
Техноэкономика. 2022, Том 1, № 1. С. 65–74.

Scientific article
UDC 330.46
DOI: https://doi.org/10.57809/2022.1.1.6

DIGITAL TRANSFORMATION OF BUSINESS: APPROACHES AND DEFINITIONS

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Abstract. The relevance of this paper is due to the rapid development and spread of modern digital technology in many areas of human activity, including the banking sector. Effective banking now requires not only a reinforcement of classical banking theory, but also a deep understanding of the future of banking institutions in today's digital transformation. This paper examines information about the change in banking institutions due to the implementation of digital transformation of their systems and the development of financial technology.

Keywords: digital technology, banking system, digital transformation

Citation: Levina A.I., Galanova A.A. Digital transformation of business: approaches and definitions. Technoeconomics. 2022. 1 (1). 65–74. DOI: https://doi.org/10.57809/2022.1.1.6

Научная статья
УДК 330.46
DOI: https://doi.org/10.57809/2022.1.1.6

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ БИЗНЕСА: ПОДХОДЫ И ОПРЕДЕЛЕНИЯ

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Аннотация. Актуальность данной статьи обусловлена стремительным развитием и распространением современных цифровых технологий во многих сферах человеческой деятельности, в том числе и в банковской сфере. Сегодня эффективное банковское дело требует не только укрепления классической банковской теории, но и глубокого понимания будущего банковских учреждений в условиях сегодняшней цифровой трансформации. В данной работе рассматривается информация об изменении банковских учреждений в связи с внедрением цифровой трансформации их систем и развитием финансовых технологий.

Ключевые слова: цифровые технологии, банковская система, цифровая трансформация

Для цитирования: Лёвина А.И., Галанова А.А. Цифровая трансформация бизнеса: подходы и определения // Техноэкономика. 2022. Т. 1, № 1. С. 65–74. DOI: https://doi.org/10.57809/2022.1.1.6

Introduction

It's hard not to see how rapidly digital technology is having an enormous impact on the nature of today's banking system. Through the coronavirus pandemic, financial institutions have seen the need to accelerate the digital transformation of the banking industry.

When the economy slows down, banks face the challenge of maintaining demand and attracting additional resources to balance the situation. But banks need to adapt their business models for both customer and internal operations to remain resilient and avoid potential future risks.

To improve smart risk management systems, the banking system needs a faster digital transformation and adoption of the latest technology underpinning it.

Materials and Methods

The following was used as methods of research of the given topic: logic, analysis, systematization of data.

Digital transformation of banks

Traditional banking institutions are currently under intense pressure from their stakeholders to adapt to new technologies. However, data security cannot be compromised, as it is a key characteristic of the relationship between banking institutions and their customers. The reputation of banks also has a direct impact on their success, their ability to attract new customers and retain existing customers. These issues mean that making decisions about how to deal with the challenges of implementing digital transformation and cybersecurity in the banking sector is quite a challenge (Rodrigues et al., 2022).

The method of digital transformation of large banking institutions offers useful insights and is applicable to many businesses, proving useful in solving complex criterion problems for stakeholders. As early as March 2020, a massive and rapid response by central banks to the dire financial situation caused by COVID-19 could be noted.

Today much attention is paid to the analysis of the impact of digital trends on the procedural scheme of a traditional bank, because it is modern digital technology that significantly affects the key processes of the banking sphere of activity (Khanboubi et al., 2019).

Significant easing of monetary policy, massive provision of liquidity and targeted credit support to the real sector of the economy all played their part in stabilizing financial conditions and lending.

Moreover, more programs were implemented in 4 months than during the entire global financial crisis. Overall, there is evidence that central bank actions have been positive – for access to credit and for the real economy – in very difficult times.

But this early conclusion has two caveats: First, in a pandemic, the role of the central bank was categorically limited. At best, it could soften the blow with credit and financial easing and thus provide a bridge to future economic recovery.

It is important to note that the financial system was quite strong at the beginning of the COVID crisis, reflecting a relatively long global economic expansion, as well as much stronger capital and liquidity buffers in the financial system, especially in the world's largest banks.

A key objective of central bank policy since March 2020 has been to provide sufficient support to the real economy to prevent a large negative feedback loop between bankruptcies and defaults in the real economy and the financial sector (Nguyen et al., 2022).

Thus, in response to the economic collapse, the management of banking institutions began to implement sets of programs of digital transformation of internal systems, which was to help overcome both real and financial difficulties caused by the pandemic.

The actions and programs of the central bank can be divided into three categories: monetary policy, provision of liquidity/lender of last resort for the financial system and targeted lending programs aimed at supporting the players of the non-financial sector: firms, households, municipalities.

It is worth noting that these actions were accompanied by regulatory easing measures, including easing capital and liquidity standards, and relaxing market regulation and restrictions on activities in the financial sector, again to make financing more available at lower cost.

Easing monetary policy during an economic downturn is a fairly standard operation. Almost all central banks around the world have cut interest rates sharply. In many advanced economies, interest rates have been set at the effective lower bound, and "unconventional" policies, such as asset purchase programs, have been initiated or expanded ("Global Economic Prospects, June 2020," n.d.).

Moreover, a number of emerging market central banks have not only cut rates, but also started asset-buying programs, something that was new to some of them. The notable exception is that central banks with negative interest rates have not cut their rates further.

In the end, the massive asset purchases paid off: yield volatility was reduced within days. Asset purchases thus eased global financial conditions, allowing banks, investment firms, individuals, and countries around the world to continue to finance themselves and provide bridge loans (Mosser, 2020).

Digital banking

Of course, digital banking today is different from traditional banking both structurally and physically.

It is worth noting that in an increasingly digital world, trust is still at the heart of banking. However, the nature of banking and financial services is changing dramatically.

To improve practice, key banking decision makers must work on innovative actions related to the use of big data, distribution and sharing of cloud technology. This will reinforce key banking principles that encourage the multifaceted use of digital technology to achieve strategic goals (Tseng et al., 2021).

Over the past decade, the industry has seen a decline in profitability as measured by the return on tangible capital. These trends accelerated after the 2008 financial crisis.

At the same time, technology has made banks more competitive. Advances in digital technology are actively changing the very nature of banking, as banks are already distributing services through mobile technology.

The Internet is having a big impact on changing the traditional banking system: this includes changing the way financial service providers perform their role. This, in turn, is changing the nature of banking services and the way they are delivered.

As a consequence, in order to compete in a changing digital landscape, banks must adapt. The banks of the future, both incumbent and challenger, must address the transformation of liquidity, data, trust, competition and digitalization of financial services. Against this background, incumbent banks are focused on reinventing themselves, while challenger banks are starting from scratch (Fama, 1980).

Also, one of the main obstacles to the implementation of a general-purpose central bank digital currency (CBDC) is the risk of bank disintermediation, potentially jeopardizing financial stability and the bank lending channel of monetary transmission (Fegatelli, 2022).

For this reason, there is a need to revise the existing analytical framework. Banks perform payment and transfer functions for the economy. However, modern digital technology can now facilitate and even perform these functions. The way transactions are recorded in ledgers is changing, facilitating the creation of both public and private digital currencies.

In the past, banks operated in a world of information asymmetry between themselves and their customers, but this is now actively changing. This differential gave one bank an advantage over another through knowledge of its customers. The digital transformation that financial technology brings with it reduces this advantage, because this information can be analyzed digitally. Even the nature of deposits is changing. Banks have to accept deposits and process transactions made digitally, either in Central Bank Digital Currencies (CBDC) or cryptocurrencies (Broby, 2021).

This creates a number of problems, among which are found: changes in the way financial services are provided; the need to discuss sustainability, security and competition in payments, which also affects the issue of private and public issuance of money. In other words, there are more and more questions on the topic of threats to the financial stability of banking institutions.

The development of modern financial technology has made it possible to convert the format of storing money into digital form, which from now on allowed creditors and investors to receive funds directly through the Internet, and transfer money digitally (Song and Thakor, 2010).

On this basis, there are discussions that financial technology is capable of fully displacing the traditional banking sector, and the competitive pressures that arise will determine the banks of the future.

Typically, the digital transformation process (the adoption and use of new digital technologies to drive significant business improvement) is presented as a strategic and rational process with clear roles, the most important of which is the chief digital officer, who is often appointed in a temporary position to lead the digital transformation.

At present, it is permissible for digital transformation of an area of activity to take place without a chief digital officer, but instead to be managed jointly with a team of top managers. Based on this, it can be argued that digital transformation can be understood as distributed leadership, allowing for a more holistic approach to mobilizing and sustaining digital transformation (Lorentzen, 2022).

Robotics is increasingly being used to automate customer interactions, increasing efficiency, control and execution quality. Application Programming Interfaces (APIs) bring the same type of functionality to mobile banking. They are also used to authorize the use of banking data by third parties.

Overall, financial technology has evolved to the point where online banking and banking as a service are challenging incumbent companies and the nature of banking intermediation. Banking is rapidly being transformed by changes in such technologies.

Electronic and mobile banking is ubiquitous today. Almost everybody uses it in some form or another – typically via mobile apps or web services. And there are many suggested and implemented security means, such as SMS codes, mobile tokens and so on (Wodo et al., 2021).

In financial theory, banking provides an accounting system for transactions and a portfolio system for holding assets. For the banks of the future, this will not change. In practice, traditional banks compete for deposits through the interest rate they offer.

This makes the transactional element dependent on the resulting debits and credits they process, turning banks into accounting organizations with an intermediary function. Because this occurs in response to competitive forces, the overall equilibrium is passive. Thus, the banking business model is vulnerable to disruption, especially as a result of innovations in financial technology.

A bank's equity capital consists of authorized capital and outstanding reserves. The latter are held by the bank to protect the bank's deposit customers. This portion is also mandated by regulations to protect customers and the entire banking system from systemic failure. These protections include requirements to hold cash reserves or other liquid assets.

Practice shows that banking services can be provided over the Internet without these safeguards, fundamentally changing the nature of protection and the way banks convert assets. Already today, the development of financial technology is actively influencing the competitive environment and thereby determining the nature of the bank of the future.

To increase efficiency and strengthen competitiveness, banks need to promote smart and practical branded services especially self-services at the same time promote a universal adoption of e-banking system services that add entertainment or extra convenience to customers such as ease of usage including digital wallet, real-time interaction (video banking), ATMs integrated with smart phones, website customization, biometric services, and digital currency. These services can contribute to an increasing adoption of online services (Yusuf Dauda and Lee, 2015).

In this respect, the threat to incumbent banks comes from peer-to-peer Internet lending platforms, as they perform the brokering function of financial intermediation without the use of a bank balance sheet. Nevertheless, it should not be forgotten that financial technology in banking is not a novel technique, as its use to facilitate electronic markets has been going on since the 1980s.

However, the nature of financial asset trading is changing. Price-setting can now be done via the Internet, moving liquidity from centralized marketplaces to decentralized marketplaces. Meanwhile, the nature of money itself is changing. A digital wallet for cryptocurrencies performs virtually the same storage and transmission functions as a bank, and cryptocurrencies are increasingly being used for payment. This shift to credit and debit cards, as well as solving the problem of double spending where digital money can be cryptographically secured, has led to the possibility that paper money could be replaced entirely in the future (Zuo et al., 2021).

Along with these trends, when considering what the bank of the future will look like, one must understand the unregulated lending market that competes with traditional banks. This part of the lending market has seen the growth of shadow banks. Shadow banks have taken significant market share away from traditional banks.

They perform the brokerage function of banks, but regulators have only partial control over their risk transformation or leverage. The emergence of shadow banks has been facilitated by financial technology that uses alternative trading systems that function as electronic communication networks.

They facilitate the creation of dark pools of liquidity in which buyers and sellers of bonds and securities trade over-the-counter. After the credit crisis in 2008, total assets of broker-dealers began to differ from bank assets. This indicates a change in lending conditions.

As noted, the bank of the future in its various manifestations will be a consequence of the evolution of the current banking business model. It has been suggested that there are three aspects of this evolution of banking, namely competition, complementarity and co-evolution (Kitsios et al., 2021).

Although liquidity transformation is evolving, it remains central to the role of the bank. Against the backdrop of all these trends and changes, new dynamics define the future of the banking sector. Market liberalization has already changed banking by increasing competition.

The impact of technology on productivity should prove positive and improve the functioning of the national financial system. New fee-based ancillary financial services as well as proprietary use of balance sheets have become widespread. Risks have been protected and even packaged into tradable products.

Over the past three decades, several financial and banking sector reform programs have been implemented in various countries. The main purpose of these reforms has been to improve the oversight and regulation of the banking sector, to introduce a mechanism for bank privatization, and to stimulate competition and financial innovation (Shaikh et al., 2017).

At the same time, financial technology is contributing to the development of banking as a service. We are talking about situations where financial services are provided by a broker over the Internet without reference to a balance sheet. This could include "robo-advisory" asset management, peer-to-peer lending and crowdfunding.

Its growth will be aided by Open Banking as it becomes more geographically widespread. Commercial pressure is also shaping the banking industry. The desire for cost efficiencies has forced incumbent banks to look at their personal costs. As technology advances, bank branches are closing. Branches make it easier to withdraw or transfer deposits, and challenger banks don't find it as easy to attract new deposits.

The use of modern digital technology can significantly improve bank operations in three ways: in reducing operating costs, in simplifying transactions between customers within the same network, and in reducing increased time costs (Ahmadirezaei, 2011).

Therefore, the banking sector is looking for new customer touch points, such as supermarkets, post offices and social media platforms. These structural challenges are occurring at the same time as the development of retail. Banks are actively adopting automated cash registers, reducing branches and headcount. Digital online transactions have become the norm in most developed countries.

Public administrations are investing in the digital transformation of their citizen-centered services and internal administrative processes. They are using co-production approaches and engaging different types of stakeholders in these transformational processes to improve service quality and create public value (Scupola and Mergel, 2022).

Bank financing is also undergoing significant changes. Traditional banks tend to finance illiquid assets with short-term and volatile liquid liabilities. This is one of the key factors contributing to the 2008 credit crisis. Providing liquidity as a last resort is central to the asset transformation process. In this respect, the banking sector experienced a shock in 2008, the so-called credit crisis.

The aforementioned liquidity mismatch meant that the system could not absorb all the risks associated with lending. Central banks were forced to resort to quantitative easing as a result of the failure of funding mechanisms. The image of the entire banking sector has been tarnished, and the banks of the future will have to deal with this problem. The structural weakness of the banking business model cannot be solved. Nevertheless, the latest Basel standards call for further risk mitigation, improved leverage ratios, and higher levels of reserve capital.

Another lesson from the credit crisis is that more attention needs to be paid to risk culture, governance, and oversight. The independence and effectiveness of the board of directors and the experience and qualifications of senior management are now the focus of regulatory attention. Internal controls and data analysis are becoming more robust and effective, and more attention is being paid to banks' stable funding ratios.

Central banks must also adapt. To limit the elimination of intermediaries, they must ensure that the economic design of their sponsored digital currencies focuses on access for banks, interest payments relative to the bank policy rate, bank storage limits, and convertibility with bank deposits. All of these changes have implications for banks, especially with respect to funding, safe deposit storage, and the interaction of digital currency with traditional paper money.

API technologies

A new way of dealing with banking data protocols is a secure way to provide consensual access to bank customers' financial information. Essentially, a bank customer grants a regulated API permission to securely access their banking site.

This access is then used by the banking organization to make direct payments or upload financial data in order to provide a solution. This heralds the era of customer-centric banking.

Open banking was a response to the documentation of people's desire to change bank accounts to make it easier to change banks by allowing customers to delegate their financial data to others. This has resulted in a plethora of data-driven applications. Open banking, by virtue of the use of modern digital technology, gives added impetus to reshaping the future of banking. In addition to all of the above, it will reduce the cost of ownership of the IT infrastructure of banking institutions (Ilin et al., n.d.).

Open banking has a number of completely revolutionary implications, including the ability for a customer to make a change of banking institution and still have a clear view of the new banking financing, which will also allow finances to be consolidated in one place. Open Banking APIs create a secure, data-driven online financial marketplace.

Open Banking allows developers to create separate API-based solutions that solve very specific problems, such as cash flow-based credit ratings. As the results show, Open Banking will promote competitiveness, innovation, and new product development (Williams, 2021).

Conclusion

In today's cryptocurrency-driven world, central banks do not have the same control over the money supply. Financial technology is changing the future of banking and the way banks intermediate, facilitating the emergence of digital money and the transfer of financial assets online.

It is worth noting that the use of modern digital technology makes banks more customer-oriented and more competitive. Thus, we can conclude that it is now strictly necessary to resort to digital transformation in order to maintain the level of competitiveness of most of the banking sector.

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Статья поступила в редакцию 09.11.2021; одобрена после рецензирования 19.11.2021; принята к публикации 24.11.2021.
The article was submitted 09.11.2021; approved after reviewing 19.11.2021; accepted for publication 24.11.2021.

Научное издание

Technoeconomics

Том 1, № 1, 2022

Учредитель, издатель – Федеральное государственное автономное образовательное учреждение высшего образования «Санкт-Петербургский политехнический университет Петра Великого»

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