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НАУЧНО-ТЕХНИЧЕСКИЕ ВЕДОМОСТИ САНКТ-ПЕТЕРБУРГСКОГО ГОСУДАРСТВЕННОГО ПОЛИТЕХНИЧЕСКОГО УНИВЕРСИТЕТА

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The paper traces the chronicle of the development of Italian Confidi and of the critical pivotal and actual issues of Confidi, so to offer an appropriate frame to introduce the draft of reform of Confidi, actually under review of the Italian legislative system, and the considerations and proposals of the author concerning the theme. Object of this paper is the analysis of the historical and juridical development of Italian mutual guarantee societies. The article analyses origins and initial development of the system of mutual support for small and medium sized enterprises (SMEs), and Confidi Framework Law, issued in 2003. The paper regards AECM experience in supporting the development of SMEs. AECM is the European Association of Guarantee Institutions. Aim of their members is, each in their country, to support access to credit for small and mediumsized enterprises (SMEs). Of particular interest among historical members of AECM are to be considered the Italian members of AECM, both for volumes of guarantees issued in relation with national GDP both for number of members. Guarantees societies in Italy are historically private, mutual, and are named Confidi. The author describes Confidi structure, hierarchy and role of the Bank of Italy in the system of support to small and medium sized business in the country, being supported by recent economic and financial data of Confidi's evolution and in consideration of the ultimate approval, on July 2015, by Italian Senate, of the draft of law about a substantial reform of the argument. The author offers a critical analysis of the actual draft and concludes by proposing some considerations about the reform. The ways of further development of small entrepreneurship in Russia are proposed.

ENTREPRENEURSHIP; SMALL AND MEDIUM SIZED BUSINESS; ITALIAN MUTUAL GUARANTEE SOCIETIES; CONFIDI; DEVELOPMENT OF SYSTEM OF SMALL BUSINESS SUPPORT.

Выполнен обзор истории развития и анализ опыта общества взаимного кредита Confidi с целью предложить направления реформирования итальянского законодательства в области регулирования процессов поддержки малого бизнеса. Объектом исследования являются общества взаимного кредита, созданные ассоциациями работодателей и ремесленников. Рассмотрены происхождение и развитие системы взаимной поддержки малого и среднего предпринимательства, действующий закон о таких сообществах, принятый в 2003 г. Рассматривается взаимосвязь обществ с Европейской ассоциацией гарантийных институтов (AECM). Целью создания данных сообществ является взаимная поддержка членов, малых и средних предприятий, путем повышения доступности кредитов. Главный акцент сделан на опыте итальянских сообществ Confidi, обеспечивающих значительный объем кредитов. Итальянские общества взаимных гарантий являются частными организациями и есть результат инициативы ассоциаций предпринимателей и ремесленников. Анализируются иерархия, структура Confidi и роль Банка Италии в системе поддержки малого и среднего предпринимательства в стране и контроле деятельности Confidi, а также экономические показатели Confidi; приведены статистические данные. Автор анализирует на основе статистических данных различие в результатах деятельности Confidi в Северной и Южной Италии, дает объяснение этому феномену, в частности приводит структуру рынка Confidi и выделяет ключевые факторы, определяющие эти различия. Описаны специфические особенности политики в области поддержки малого и среднего бизнеса в условиях кризиса, приведены соответствующие стати-

стические данные. Выявлены проблемы и барьеры на пути реализации задач Confidi, выполнен критический анализ предложений по совершенствованию итальянского законодательства, в частности проекта реформ 2015 г. — проекта Закона № 1259. Предложен ряд мер по совершенствованию системы поддержки малого бизнеса.

ПРЕДПРИНИМАТЕЛЬСТВО; ЕВРОПЕЙСКИЙ БИЗНЕС; ПОДДЕРЖКА МАЛЫХ И СРЕДНИХ ПРЕДПРИЯТИЙ В ИТАЛИИ; ОПЫТ ООБЩЕСТВ CONFIDI; ПЕРСПЕКТИВЫ РАЗВИТИЯ.

1. Introduction. Confidi are mutual guarantee societies primarily promoted by employers' associations (manufacturers, traders, craftsmen), which directly operates in favour of member companies by issuing guarantees for bank loans granted to SMEs associated. The historical aim of the Confidi is to facilitate credit access for smaller enterprises.

In Italy, a Confidi represents a pivotal financial and economic actor in the supply chain in the process of granting credits to SMEs. The history of the Confidi, as well as their development, is indissolubly connected to Italian industrial development, since the Italian industrial system is characterized by a dominant presence of SMEs, mainly of micro and small dimensions.

It is therefore essential, in order to support Italian industrial development, to ensure the sustainable and organic development of the Confidi, particularly by means of legislative instruments, leading them towards a progressive and inevitable structural and operative reorganization.

The analysis of the evolution process of the Confidi, both at a historical and a legislative level enables a more factual comprehension of the actual difficulties they are facing and introduces the proposals for solving these difficulties.

2. History of the Confidi
a) *Origins and initial development*

An instrument of financial guarantee which supported the creation of the cooperative of mutual guarantee as a juridical figure was introduced in the Italian system in 1956 with the issue of organic legislation about craftsmen. Towards the constitution of this juridical figure, which offered guarantees for loans requested from associated craftsmen, public funds were provided in order to support and promote the diffusion of private activity. The first cooperative of mutual guarantee for craftsmen was constituted in 1957, while the diffusion of industrial consortia and cooperatives in the industrial field to guarantee loans requested by the associated in order to allow access to credit for Italian SMEs started only in the 1960s, and only partially, because of the initial lack of an authorized established juridical form, afterwards identified as a consortium or cooperative. The support of the Confidi becomes essential in the 1970s, with the Italian economic crisis and the connected difficulties of Italian SMEs to be financed by credit institutions. The first national federation of Confidi, named Federconfidi, was founded in 1971 in the manufacturing field, and the first regulation of their activity which recognized their contribution to SME development was issued in 1977 and granted them favourable fiscal treatment, the possibility to obtain public aid from regions and from other forms of local government, the recognition of the mutual non-profit spirit of the Confidi. It was in this period that the central fond of guarantee by Mediocredito Centrale[1] was introduced.

The leading role of the Confidi as collective credit guarantors within the Italian entrepreneurial system was recognized in 1991[2]. The Italian law defined them as «granting financial activity to SMEs and providing essential information for a more accurate evaluation and rating of SMEs in credit intermediation». Their effective role in reducing the asymmetric information afflicting credit intermediaries evaluating SMEs interested in access to credits was furthermore identified. Italian law introduced the minimum requirements for the Confidi with regard to enterprise shareholders and capital requirements. A fund of

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[1] Mediocredito Centrale was created in 1952 as a public law institution to distribute public financial aid, facilitations and support to the process of internationalisation of SMEs; in 1994 becomes a public company of private law held by state entities also aimed to Project & Export Finance, industrial finance and loans, leasing and factoring; today it is a Bank aimed at supporting the development of Southern Italy and of Italian SMEs, offering financing for SMEs, loans for private, management of European and national distribution of funds on behalf of the public administration).

[2] Law No. 317/1991.

guarantee was created to absorb losses due to non-performing credits guaranteed to SME shareholders. The fund of guarantee is guaranteed and covered up to 30 % by the State. The operative skeleton of the Confidi took shape with the establishment of the *National Federations of Confidi* and of the *National Coordination of Confidi* (mainly with representative functions). National, regional and interregional forms of agreement and coordination of the Confidi are progressively instituted. The general reform of the bank codification, in the 1990s, imposed registration of the Confidi in a special list of financial institutions, in accordance with criteria established by the Consolidated Law on Banking, so-called TUB. Confidi are listed in a special section of the new TUB and are consequently obliged to fulfil financial statements in accordance with the provisions of the *Bank of Italy*[3]; new measures are approved, like the anti-usury fund and the possibility for Confidi to counter-guarantee or co-guarantee bank bonds.

b) Confidi Framework Law, 2003

It was in 2003 that the Italian legal system witnesses a general reform on the discipline regulating the Confidi, by means of the so-called Confidi Framework Law[4].

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[3] The Bank of Italy is the central bank of the Republic of Italy. It is a public-law institution regulated by national and European legislation. It is an integral part of the Eurosystem, which is made up of the national central banks of the euro area and the European Central Bank. The Eurosystem and the central banks of the member states of the European Union that have not adopted the euro make up the European System of Central Banks.

The Bank pursues aims in the general interest in the sector of money and finance: price stability, which is the main objective of the Eurosystem under the Treaty on the Functioning of the European Union; the stability and efficiency of the financial system, thus implementing the principle of the protection of savings embodied in the Constitution (Article 47 states «The Republic encourages and protects saving in all its forms, it regulates, coordinates and controls the provision of credit»); and the other duties entrusted to it by Italian law. As regards supervision, the Bank of Italy is the competent national authority for the Single Supervisory Mechanism (SSM) for banks.

[4] Article 13 of Legislative Decree No. 269 dated 30 September 2003, transformed into Law No. 326 of 24 November 2003.

The main constituents of the Confidi Framework law are listed in the following Scheme:

Main Costituents of the Confidi Framework Law

Legal status	Establishment of legal status: consortia with external activity; cooperative society; limited liability or share capital consortium
Company object	exclusively focused on activities concerning joint credit; guarantee-granting and related or instrumental services
	Mutual non-profit activity
Registered capitai	Consortium fund or share capital not less than €100.000, with the exception of certain consortia that must comply with the threshold; amount of €120.000, as provided for by the civil code
	Threshold share for each company set at €250; shares may not exceed 20 per cent of share capital
Equity	Equity including risk funds less than €250.000
	Contributions by members/shareholders not less than one fifth of the equity
Associate companies	SMEs, as defined by the EU regulations (number of employees below 250; turnover less than €50 million; total assets less than €43 million)
	Companies of larger dimensions, within the boundaries set by the European Union, with regard to EIB interventions in favour of SMEs (fewer than 500 employees, net fixed assets up to €75 million); companies exceeding the above parameters may not hold more than one third of shares), as more as they represent not more than one sixth of the associated companies
	Companies of greater dimensions compared to the previously mentioned ones, only provided their share of capital was underwritten prior to the coming into effect of the Framework Law on Confidi
Subject requirements	Subject holding shares and subjects with administrative, management and supervision duties must comply with fit and proper persons' tests

Confidi Framework Law introduced 3 organizational models of the Confidi:

a) A traditional model of the Confidi entered in a special list referred to in article 106 TUB (henceforth Confidi 106);

b) The Confidi of financial intermediaries entered in the special list referred to in art. 107 of TUB (henceforth Confidi 107);

c) The Confidi Guarantee banks

Here are the main features of each organizational model:

a) Confidi 106 − they are obliged to be registered in a special list. Core activity limited to collective loan guarantees and connected, as well as instrumental, services (i. e. advisory services, or outsourcing of information services). Handling of public funds is limited to a temporarily period of three years.

b) Confidi 107 − Financial intermediaries − supervised by Bank of Italy. The Confidi whose guaranteed activities and assets exceed a certain limit set by the Ministry of Finance must be established in this form[5].

They are entitled to:

− *as predominant activity,* issue Basel-compliant guarantees and counter-guarantees, as well as guarantee-related and instrumental activities, respecting fixed parameters of profitability and dimensions. In other words, they can provide, mainly to SME shareholders, collective loan guarantees; in addition, they can offer guarantees to the State as well as stipulate contracts with banks' assignees of public guarantee funds;

− *as residual activities* (within the limit of 20 % of the total assets), they are allowed other activities carried out by financial intermediaries 107 TUB (exchange intermediation, underwriting shares, loans, payment services).

Confidi 107 are subjected to the application of regulatory framework equivalent to that of banks. This allows to obtain the best possible prudential treatment provided by credit risk mitigation (CRM) as per Basel II, as a more favourable risk weighting is applied to bank loans granted by the Confidi, and as the guarantees offered by such intermediaries are recognized as reducing the lending bank's credit risk.

c) Confidi guarantee banks − established in the form of cooperative *Confidi 107 compared to Confidi 106* societies and recorded in a special list, their predominant activity must be mainly joint loan guarantee−granting activities to the advantage of their shareholders. They may additionally offer banking activities, as well as related and instrumental services. Since they are considered compatible, TUB regulations for cooperative banks also apply to Confidi guarantee banks.

Competitive advantages	Disadvantages
guarantor admitted in the credit risk mitigation (CRM[6]); able to offer: loans, advice on the treasury management and corporate banking services; able to diversify type of guarantees issued 8 according to the approach adopted by the bank for capitl provisions related to credit risk; management of public incentive funds without restrictive conditions; access to tender calls for allocation of public resources (i. e. fund for financing enterprises); able to access international channels of counter-securities and reinsurance	respect of supervisory standards regarding organizational arrangements, quality of management, ...; high compliance costs; transparency of cost structure and risks

c) 2003−2010

The business model of Italian mutual guarantee societies, defined as 'Confidi', changed radically at the end of the first decade of the twentieth century.

Two factors contributed to this change:

1. The regulations issued by the Bank of Italy requiring mutual guarantee societies with assets exceeding Euro 75 million to apply for inclusion

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[5] In particular, the passage to Confidi 106 (minor Confidi) to Confidi 107 is mandatory when, according to financial statements, the volume of financial activity is more than 75 million euros.

[6] In Pat II, Chapter 2 of Circular letter 263/2006, issued by the Bank of Italy, CRM (credit Risk Mitigation) techniques are defined as the set of instruments that can be employed by banks as credit protection. The procedures for allocating different types of credit protection depend on which approach is adopted by banks in calculating credit risk capital requirements (standardized, foundation IRB or advanced IRB). Anyhow the pressing requirements of Basel II have made it impossible to acknowledge guarantees issued by Confidi 106 with regard to credit risk mitigation.

in the Register of Regulated Intermediaries, and hence to be subjected to the Bank of Italy supervision;

2. The government measure adopted to recapitalize the Central Guarantee Fund, the main activity of which was the backing up of the guarantees provided by the fund with an ultimate guarantee by the State.

Prior to the issue of the Bank of Italy regulations, mutual guarantee societies were not subjected to capital requirements. Their management was focused exclusively on the management of counterparty risk.

For the first time, Bank of Italy introduced an obligation for mutual guarantee societies to comply with capital requirements. This obligation changed their approach to market: risk management continues to play an important role in the management of the Confidi, but the strategic element for development is now 'capital'. The significant capital size enables mutual guarantee societies to expand their operations and reach the critical mass which is mandatory in order to cover the additional costs associated with supervision, and accordingly to manage their business efficiently. Thus 'capital' is referred to as a strategic element for development and this new element creates a remarkable contrast with the previously existing legislation resulting from the historical times, as mutual guarantee societies were the result of a mutualistic, no profit spirit, which concretely limited in a significant way the ability of a mutual guarantee society to attract venture capital.

Support for the repositioning of the Confidi was offered by the Italian Government, which radically changed the nature of the Central Guarantee Fund[7].

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[7] The Central Guarantee Fund is a public fund created after the turn of the millennium in order to facilitate access to credit for SMEs. Until 2008, the fund's activity was relatively modest: it was used on a highly sporadic basis by banks and mutual guarantee societies for more problematic transactions. The fund theoretically provided risk coverage (it covered between 60 per cent and 90 per cent of exposure) though its administrative management was so complex that it significantly reduced any interest in its use. Furthermore, the guarantees issued by the fund did not provide any advantage in terms of capital reduction.

The Fund was recapitalized, equity was increased but the most relevant element was the provision of coverage for the guarantees issued by the Fund by an ultimate guarantee from the State. This measure enables the Confidi that are in turn guaranteed by the Fund not only to cover their risk but also to reduce capital absorption. The intervention of the Central Guarantee Fund made it possible for major mutual guarantee societies to increase their support for SMEs without any increase in risk and without causing any particular tensions in terms of the parameters measuring their intermediary's solvency.

The major Confidi not only relied on the Central Fund but also used all other instruments which public operators (regions, provinces, Chambers of Commerce, etc.) activated in order to facilitate access to credit for SMEs.

Of particular relevance is the credit limit made available by *EIF*[8] (European Commission's instrument of economic policy) for intervention in favour of SMEs.

Over this decade the major mutual guarantee societies have gradually transformed themselves from guarantor bodies into organizations acting as intermediaries which distribute guarantee instruments activated by public authorities.

Furthermore, the economic crisis and the tensions within the banking system on the liquidity front have strongly accelerated the trend of the aggregation process already in act within the mutual guarantee societies.

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[8] The European Investment Fund (EIF), www.elf.org, as Europe's leading developer of risk financing for entrepreneurship and innovation, has been established to provide access to finance for SMEs. EIF delivers a wide range of innovative financing solutions for micro, small and medium-sized enterprises throughout Europe. These solutions, including equity, guarantees, credit enhancement and microfinance, are delivered through financial intermediaries. EIF's objective is to support EU policy objectives especially in the fields of innovation, technology, growth, employment, entrepreneurship and regional development, while at the same time acting as a market-oriented organization, which achieves an appropriate return on its capital through commercial pricing and a good balance of fee and risk-based income. EIF has a unique tripartite shareholding structure combining private and public investors: the European Investment Bank (EIB), 62 %, the European Union through the European Commission (EC), 30 %, and 25 public and private financial institutions, 8 %.

The aggregation process mainly had its effects in Northern Italy, whereas in Southern Italy there remained a variety of smaller and less competitive Confidi. The aggregation process also lead to a National Unitarian Representative Organization of Confidi, «Asso Confidi»[9]. The new association's aim was the representation, at EU level, of the Italian Confidi in AECM[10] and, at a national level, the creation of a unanimous voice able to debate with continuity and authority with the Bank of Italy and the Italian Ministry of Economy about the rules and laws regulating the activity of the national Confidi.

The hierarchy of representation of the Confidi and of their operative levels became the actual ones, which can be summarized in the following Scheme.

Operative level	a) Confidi of the *1st level* The shareholders generally are SMEs to whom Confidi issue direct guarantees. b) Confidi of the *2nd level* Shareholders are Confidi of 1st level or both SMEs and Confidi of the 1st level. They mainly issue counter-guarantees and co-guarantees to Confidi of the 1st level with the aim of reducing risk supported by the Confidi operating on provincial base
Represen tative level	a) *National Federations* Mainly with functions of coordination and representation b) *National Coordination of Confidi* Unifies the 5 bigger National Federations and performs tasks of coordination and representation c) *AECM* European Association of Guarantee Institutions Represents the interests of its national members towards the European institutions and multilateral international entities

d) *Legislative Decree No. 141/2010: an incomplete reform*

Legislative Decree No. 141/2010 substitutes title V of TUB completely, in particular the part about financial intermediaries[11].

A form of official prudential supervising was required for the Confidi. At the achievement of a certain volume of financial activity[12] established by the Ministry of Economy and Finance,

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[9] At the end of 2006 was created the organism «Asso Confidi» whose goal was to unify, as a representative unity, all the different federations of guarantee consortia acting in the fields of agriculture, craftsmen, commerce and manufacturing This new aggregation represented in 2006 more than 1 million of SMEs, producing a volume of guarantees able to distribute more than 22 milliard euros to all SMEs associated.

[10] AECM, European Association of Guarantee Institutions, www.aecm.eu, is a European association the members of whom, each in their own European country, support healthy SMEs with a business project that would otherwise not be able to access loan finance due to a lack of collateral and own funds. By granting a guarantee, guarantee societies provide a substitute for the missing collateral and allow the credit institution to grant the loan by sharing in the default risk. Guarantee organisations have been set up in nearly all European Member States, as well as in Montenegro, Russia and Turkey. In addition, guarantee schemes also exist beyond Europe, e. g. in the US, Latin America, Asia and the Mediterranean region. AECM, as the European association of mutual guarantee societies, represents the interests of its national members towards the European institutions and multilateral bodies, such as the OECD, the World Bank and the Bank of International settlement. AECM also acts as a platform for exchange between its members and provides technical information about the guarantee sector.

While in each European country there are one, maximum two associated members of AECM, Italy, because of its historical representative fragmentation, provides eight associated members, each of whom represent a particular category of interests. Each of them are a reflection of the variety of Confidi still existing in Italy.

[11] The reasons submitting the reform were to be found in the restrictions induced by international regulations. In application of Basel II and in the perspective of the introduction of Basel III, which aimed at the enhancement of the capitalization of financial intermediaries and of the patrimonial operational requirement of coverage of exposures towards other financial enterprises, just adequate instruments of guarantees issued by supervised institutions, or of high rating, could be considered, in the purpose of risk mitigation and of capital consideration, able to reduce the capital requirements on the corresponding bank loans. The guarantees that Confidi can issue −mainly 'fidejussioni', a kind of personal guarantee − couldn't enable a reduction of the patrimonial requisites needed to lean to risk mitigation and patrimonial coverage.

[12] In particular 75 mil. euros for Confidi already registered as anterior Confidi 106; 150 mil. euros for Confidi of new enrolment (new application) in the Register of Regulated Intermediaries

Confidi ought to enrol in the Register of Regulated national financial Intermediaries. The enrolled Confidi have an operational sphere of intervention wider than the non-enrolled Confidi.

Previous Confidi 107 essentially maintain the same supervision structure and are authorized to be registered in the Register of Regulated financial Intermediaries, directly organized and supervised by the Bank of Italy. Therefore they are qualified as financial intermediaries.

A system to supervise minor Confidi (mainly Confidi 106 in Confidi Framework Law of 2003) has also been introduced. A self-regulatory body, a legal entity of private law, is supervised regularly by the Bank of Italy, with organizational, statutory and financial autonomy. It is in charge of keeping the register of smaller and microcredit collective loan-guarantee entities, as well as of supervising the entities recorded in that register, with power of expulsion of non-compliant Confidi.

Both provisions are still waiting for a factual organic implementing regulation.

3. Confidi and the crisis, the actual scenario: some data

Some data to underline the effective support offered by Confidi to SMEs in the acute phase of the financial crisis: between 2007 and 2009 credit to enterprises guaranteed by Confidi has increased to an average annual 2.1 %, compared to an average annual decrease of 1.4 % for enterprises not guaranteed by Confidi. At the end of 2009, the quota of loans issued to enterprises with less than 20 workers and guaranteed by Confidi represented about 13 % of the total credit granted to enterprises with less than 20 workers from the entirety of the Italian bank system.

The data elaborated by AEGM clearly illustrate how in the years 2011 and 2012, the organization of Confidi, in the Tables referred to as Asso-Confidi, maintains its role of absolute predominance as a credit guarantor among AEGM associated in the EU scenario, supporting access of SMEs to credit.

Figure indicates the proportion of the outstanding guarantees in portfolio of each member towards AECM total comparing 2011 and 2012 (in % of total).

In what concerns the cost reduction to access credit, at the end of 2007, enterprises guaranteed by Confidi obtained short-time loans to average rates of interests lower by 20 base points than others. Such a cost advantage

extended during the crisis: at the end of 2009 the differential slightly increased arriving to 30 base points with particularly intense effects on the Southern Italy enterprises (1.4 % point), followed by the North-East and Centre enterprises (0.4 % and 0.5 % point).

The structural discrepancies existing between Confidi dislocated in Southern Italy and other Confidi become evident, as in Southern Italy the crisis hit the manufacturing system harsher and enhanced credit grip. The general gap existing between Southern and Northern Italy can be summarized in the following points (Figure).

Southern Italy was just marginally involved in the drastic aggregation process of Confidi which occurred in the Northern and Central Italy in the 2000−2010 decade and which led to a connected reduction of their operative costs and to an enhancement of production efficiency;

− Dimensional parameters of the Southern Italian Confidi (average number of enterprises associated, capitalization) highlight the problem of their microscopic dimensions;

− The pathological low levels of net assets entail the issuing of guarantees of inadequate average amount and group them in the class of minor loans;

− In Southern Italy the indicators of average high solvency (net assets/ guarantees) reveal a particular cautious inclination in issuing guarantees as well as a less intensive exploitation of available resources.

Source is the Central Credit Register[13] of the Bank of Italy.

Tab. 1 and 2 concerning the data of 2013 confirm the above-mentioned scenario, offering further information about the geographical coverage and sector allocation of collective guarantees with particular evidence on small enterprises, intended as not financial enterprise with less than 20 workers.

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[13] The Central Credit Register ('Centrale dei Rischi') is an information system on the debts of the customers of the banks and financial companies supervised by the Bank of Italy.

The Bank of Italy collects information on customers' borrowings from the intermediaries and notifies them of the risk position of each customer vis-a-vis the banking system.

By means of the Central Credit Register the Bank of Italy provides intermediaries with a service intendedimprove the quality of the lending of the credit system and ultimately to enhance its stability.
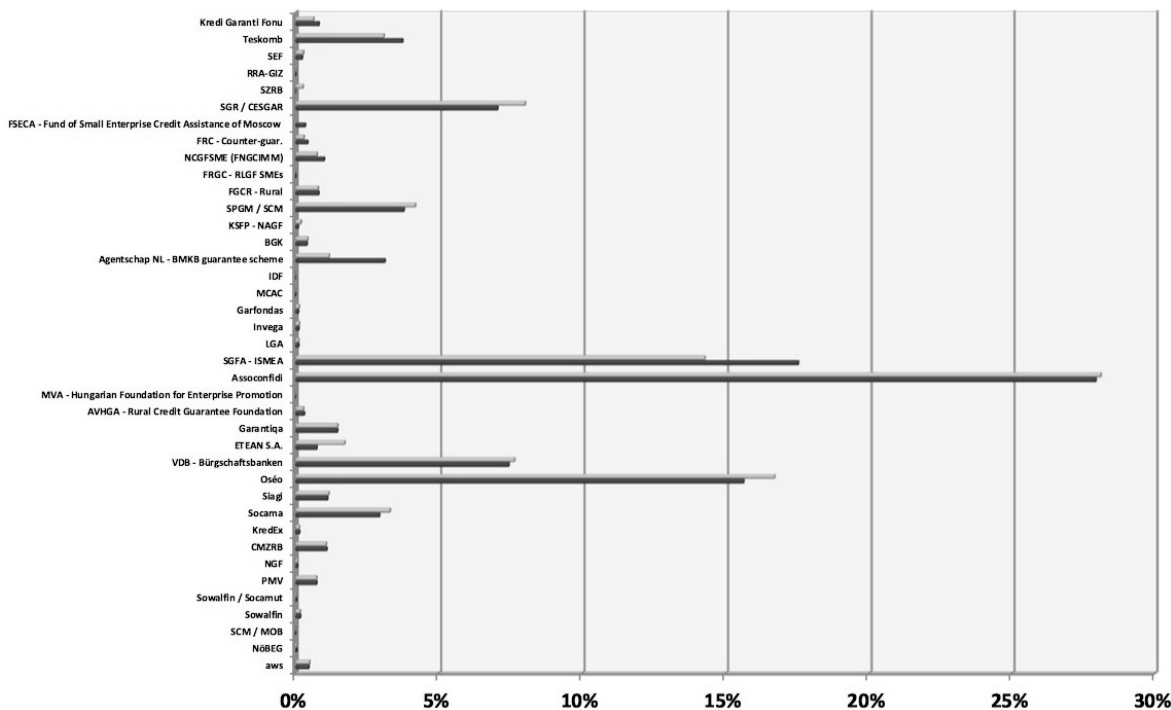
Proportion of the outstanding guarantees in portfolio of each member towards AECM total:
comparison 2011 and 2012 figures (in % of total AECM pordfolio)
(▢) − 2011; (▪) − 2012 (provisional figeres)

Tab. 1 summarizes the structural market of the Confidi by geographical allocation. At the end of 2013, of the 617 total number of Confidi registered in the register hold by Bank of Italy, 306 were based in Southern Italy, 133 were located in Central Italy and respectively 98 in North-West and 80 in North-East of the country. It is the evidence of the process of concentration which is clearly incomplete in Southern Italy, and more effective in other geographical areas of the country. The fragmentation in a multitude of small and microscopic organizations is corroborated by the data of the total amount of guarantees issued: the Southern Italian Confidi issue the more exiguous volume of guarantees, 3.9 bn euros in 2013, compared to 8.5 bn euros in North-West. The average value of issued guarantees in Southern Italy is just 17.7 m euros, almost a third of the average value at national level, equal to 43.6 m euros, whereas the maximum average amount issued in North-West is 97.1 m euros.

Also the average geographical operative area of intervention of Southern Italian Confidi, equal to 6.4 provinces, is reduced in comparison with the average Italian data, 11.3 provinces, and even more reduced in comparison with North-West (18.7 provinces) and North-East (16 provinces).

Tab. 2 reports the percentage of non-performing guarantees over the guarantees issued in favour of small enterprises (defined as non-financial enterprises with less than 20 workers) according to geographical coverage and sectorial allocation in 2013.

Empirical evidence confirms theoretical expectations, whereas the rate of non-performing guarantees is reported to be lower in case of credits guaranteed by Confidi in comparison with credits not guaranteed by the Confidi. In fact, the activity of supervision and preliminary screening offered by the Confidi should emphasize the action of selection of the issuer bank, offering a sample of enterprises with a higher degree of solvency or at least reducing the overall asymmetry of information of the issuer bank due to a less penetrating level, on the side of the bank, of knowledge of the territory and the potential of each SME.

At a national level, the percentage of non-performing credits out of the total of guaranteed credits is 16.2 %, whereas the percentage of non-performing credits out of the total of credits not guaranteed by Confidi is 20.9 %.

The organization of Confidi's market, by geographical areas, 31.12.2013 (*)

Amount in € millions	North-West	North-East	Center	South	Italy
No. of Confidi enrolled in the register	98	80	133	306	617
of whom: under supervision of the Bank of Italy	17	18	12	13	60
Data from Central Credit Register No. of Confidi present in CCR	88	80	113	223	504
total value of issued guarantees	8.549	5.245	4.463	3.943	22.200
of whom: issued by Confidi 107	7.064	3.819	3.483	1.727	16.093
Guarantees offered by each Confidi Value of guarantees (average)	97.1	61.7	39.5	17.7	43.6
of whom: of Confidi 107	415.5	212.1	290.3	132.9	268.2
Guarantees offered by each Confidi Value of guarantees (median)	21.1	25.7	3.5	4.3	6.1
of whom: of Confidi 107	176.8	129.8	119.1	119.5	134.3
Extension of penetration of Confidi					
No. of provinces (average)	18.7	16.0	11.3	6.4	11.3
No. of provinces (median)	12.5	12.0	6.0	4.0	6.0
No. of regions (average)	6.8	6.9	5.1	3.1	4.8
No. of regions (median)	5.0	6.0	3.0	2.0	3.0

(*) Geographical allocation is based on the registered seat of Confidi.
Source: Central Credit Register (CCR), Bank of Italy

The national data confirms the local-level findings, although there persist significant differences in absolute values of non-performing credits: in Southern Italy the non-performing credits guaranteed by Confidi are 21.2 % and 37.8 % in case of non-performing credits not guaranteed by Confidi, in Central Italy respectively 19.9 % and 22.3 %, in North-East 11.7 % and 12.2 % and in North-West 15.8 % and 18.2 %.

4. 2015: The actual draft of reform − Draft of Law 1259

a) The reasons of the reform

At the end of 2012, there were 637 Confidi in Italy, 57 of them directly supervised by the Bank of Italy. Their number continues to decrease in accordance with the process of aggregation, mainly implemented through consecutive mergers, in order to achieve the required dimension to be enrolled in the Register of Regulated Intermediaries and essentially pass from Confidi 106 to Confidi 107. In dimensional terms, the distribution of Confidi is fragmented, as a small number of Confidi hold half of the market and the smallest Confidi generally are located in Southern Italy.

On the front of risk management, there is a noticeable decrease of guarantees in terms of risk of credit: the trend is a more restrictive policy of issue of guarantees, in particular for Confidi supervised by the Bank of Italy, connected to the more generic policy of general deleveraging by credit intermediaries as a consequence of the increasing burden of non-performing credits.

Because of the policy of rates that is not yet fully risk-based and of the high incidence of operative costs on their profitability margins, Confidi don't generate satisfactory economical outcomes. Furthermore, the quantitative progressive reduction of State aid allocated to Confidi in recent years reduces the possibility to stock capital for future risks management.

Still the coefficient of solvency for Confidi supervised by Bank of Italy respects law requirements but a new reform is considered necessary.

Table 2

Incidence percentage of non-performing loans over loans guaranteed by Confidi to enterprises of minor dimension organized by economic sector, regions and Macro-areas (a[14])

Regions and Macro areas	Total loans (b)		Agriculture		Services		Construction		Manufacturing	
	B	A	B	A	B	A	B	A	B	A
Piemonte	15.2	27.6	5.8	8.1	15.8	29.5	19.2	34.4	20.4	27.4
Valle d'Aosta	23.7	4.2	4.8	0.5	27.8	3.6	177	6.6	23.8	5.7
Lombardia	15.2	16.2	10.0	5.0	13.8	16.6	22.9	25.9	18.7	15.2
Liguria	18.5	15.3	18.4	13.8	17.2	16.1	24.4	19.9	19.9	10.8
Trentino Alto Adige	5.2	10.4	1.8	1.8	4.7	9.7	11.8	18.9	6.0	10.8
Veneto	15.0	13.6	7.4	4.3	13.6	11.6	22.9	24.8	22.0	14.2
Friuli Venezia Giulia	13.4	13.7	5.6	9.3	13.0	13.8	23.5	25.2	19.6	11.0
Emilia Romagna	15.3	8.9	8.9	2.9	13.7	9.3	26.7	18.0	18.1	10.5
Toscana	18.1	18.2	15.3	12.4	15.2	16.2	26.0	25.5	24.8	18.5
Umbria	22.7	26.2	18.4	22.8	19.2	26.7	32.0	27.1	29.8	25.8
Marche	20.4	14.8	11.7	8.8	18.4	14.1	28.2	19.0	27.5	15.4
Lazio	28.1	20.5	23.3	1.8	25.3	18.9	41.0	23.3	37.3	29.3
Abruzzo	24.8	15.8	21.8	13.7	23.1	14.1	26.0	21.0	33.4	17.2
Molise	38.2	25.3	26.8	13.2	31.4	22.7	63.0	34.4	39.1	27.1
Campania	35.0	30.4	29.6	15.1	30.2	29.4	53.9	35.4	42.8	34.2
Puglia	33.1	12.4	32.6	6.6	28.5	12.0	48.1	16.2	36.2	13.5
Basilicata	46.6	15.4	41.4	18.9	40.1	14.2	63.0	19.4	49.3	13.0
Calabria	47.1	31.1	44.4	20.9	42.0	28.8	60.5	38.1	54.3	36.8
Sicilia	41.4	19.2	40.5	19.1	36.0	17.9	58.5	21.6	45.2	21.8
Sardegna	36.0	20.1	38.7	8.4	28.8	19.1	50.5	27.4	46.4	23.5
North-West	18.2	15.8	9.8	6.9	18.7	16.5	60.9	21.7	20.7	14.8
North-East	12.2	11.7	5.9	4.6	11.3	11.1	21.2	21.7	16.4	11.6
Centre	22.3	19.9	17.2	11.5	19.5	19.0	31.8	23.7	29.9	22.3
South	37.8	21.2	34.5	14.5	32.5	19.8	52.9	26.7	43.3	23.4
Italy	20.9	16.2	14.6	6.6	18.9	16.1	31.6	23.9	25.5	17.0

[14] (a) Geographical allocation is based on the registered seat of guaranteed enterprises; data referred to those Confidi indicated as issuers of guarantees of a higher volume if compared to the threshold of individual survey, 31.12.2013

Enterprises of minor dimensions are to be considered not financial enterprises with less than 20 workers. The value of each macro-area is obtained as the mathematical mean of the values of regions included into the macro area.

(b)The total of the guarantees issued includes also guarantees issued not included in the indicated sectors of activity.

A. Enterprises guaranteed by Confidi; B. Enterprises not guaranteed by Confidi

Source: Central Credit Register, Bank of Italy.

b) Draft of Law 1259

I. The Draft of Law

On July, 2015 the Senate of Italy approved Draft of Law No. 1259 containing a mandate to the Government to organically reform the system of the Confidi.

The ultimate goal of the reform is to promote development of the Confidi and therefore facilitate access to credit by SMEs. By means of the approval, the Chamber of Senate authorizes the Government to introduce effective measures to promote and encourage the capitalization of Confidi, to improve conditions and processes of resources accumulation and to enhance the effect of the intervention of each single actor in the chain of supply of guarantees and counter-guarantees issue. An introduction of measures aimed at reducing the compliance of bureaucratic oppressive provisions for the Confidi is also expected, charging most of the provisions on banks and therefore avoiding overlapping of interventions and bureaucratic slowness of procedures, reducing the resulting managerial and procedural inefficiencies as well as structural operative costs. The *leitmotif* is simplification.

Essentially, the main actions proposed are the following[15]:

1. Promote the recapitalization of the Confidi and facilitate the accumulation of resources, deriving from public, private or from third sector actors, of current assets and of stock, identifying instruments and Basel-compliant modalities to use them in order to facilitate the access to credit for SMEs;

2. Regulate and readdress the modalities of allocation of public financial support aimed at the capitalization of Confidi in compliance with EU regulations

3. about State aid;

4. Rationalize and accelerate the chain of guarantees and counter-guarantees by optimizing the relationships between banks, Confidis and companies, thus fostering the restructuring of organizational models and of the chain of credit-guarantee-banks, Confidi, local authorities, Chambers of Commerce;

5. Develop forms of guarantees and instrumental collateral services, financial and non-financial, satisfying the new requirements of SMEs

6. Reinforce the proportionality and specificity criteria[16], extending their implementation to all the legislations about the Confidi,

II. Some proposals

The principles of the reform have been widely endorsed by actors of the field, institutions and experts invited during the related cycles of parliamentary debates.

All of them agree about the importance of the recapitalization of the Confidi and of the implementation of collateral instruments and services offered to SME associates.

In the phase of economic cycle in which we are experiencing widespread crises, the Confidi should have enough capital to absorb the risks associated with their business, even in stressful situations, ensuring continuity and efficiency of services to their customers and ability to act as intermediaries of adequate operating efficiency. In order to realize effectively the *recapitalization of Confidi*, it is first of all necessary to remove some obstacles which restrain its actualization.

First, the fragmentation and dispersion of public aid, often characterized by one-spot intervention, difficult to evaluate in terms of results and effectiveness of intervention. It is necessary to implement a model of systematic long time structured planning of public aid, enabling a clear time sheet of planned volumes and measures of disbursement. It would imply on one hand the possibility for each single Confidi to fulfil long-term strategic planning, (and therefore the connected internal scheduling of timing and volumes of issuable guarantees), and on the other hand, the policy maker could evaluate the effectiveness of the measures adopted adjusting in case of their selection. The activation of a national database collecting all existing measures of public aid (state, regional, of Chambers of Commerce, FEI, of other public institutions) and reporting their factual impact on their theoretical final beneficiaries could be useful.

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[15] See papers on the argument on the web page of the Italian Senate http.//www.senato.it.

[16] Sanctioned by the Itallian Consolidated Law on banking in its most recent formulation.

Simultaneously, it would be advantageous to create a mechanism of reward for the most effective Confidi, directing facilitations or public reliefs for instance to those Confidi which offer greater operative volumes of guarantees issued. To implement it, the Confidi should accomplish the requirement of the fulfilment of an accountability about the modalities of employment of the public resources and should be implemented an evaluation system about these Confidi. To reinforce also the mutualistic nature of the Confidi, it would be advantageous to correlate, through appropriate parameters, the amount of guarantee issued in favour of each enterprise to the amount of capital that each enterprise allocated to a Confidi to capitalize it.

In the actual situation of high general incidence of non-performing credits, it is furthermore advisable to distinguish between an ordinary public aid (aimed at supporting in an ordinary situation the enhancement of guarantees issued by 'healthy' Confidi) and an extraordinary public aid (aimed at insuring evident situations of crisis or weakness). In this latter case (extraordinary public aid), it would be possible to include the extraordinary public aid in a wider framework that considers the management of the non performing credits of the banking system towards SMEs as a whole and the creation of a bad-bank for the banking system managing non-performing credits. Just for the Confidi registered in the Register of Regulated Intermediaries identifying the technical forms of Basel-compliant public aid should be opportune, so volumes of new guarantees issuable by Confidi should be expanded. The capitalization of the Confidi could be implemented extending the range of their shareholders. The Confidi could consider as possible ordinary shareholders not only large financial enterprises/public and private entities/ banks and other financial institutions (with limited shares); a juridical figure of the 'socio sovventore'[17], literally 'promoter shareholder' should be introuded (just for the Confidi organized in the juridical form of cooperatives).

Besides the capitalization of the Confidi, of relevance is also the *development of the collateral services* that Confidi can promote in order to support the development of SMEs in the actual scenario. They could offer continuous support to the financial management of associated SMEs, implementing SMEs system of financial planning and scheduling. Therefore, they could become a reliable intermediary of banks about the solvency of the SMEs associated and the reliable interlocutor of associated SMEs to prevent or restore financial problems.

Considering the possibility to offer further services to support access to credit for SMEs, Confidi could also grant mutual guarantees in order to cover partially mini-bonds issued by Italian SMEs not listed on the Stock Exchange[18], as well as grant guarantees to subjects recently authorized to grant credits[19]. The Confidi could also take part in more sophisticated interventions, such as tranched covers.

These are just some proposals of the activities that the Confidi could actuate, but still sufficient to reveal the enormous potential of the Confidi.

5. Conclusions. Confidi are recognized as a pillar of the Italian guarantee sector. Their historical origins and their ability to accompany the Italian enterprises efficiently through all the different phases of their progressive evolution reveal the indissoluble connection that ties them tightly with the economic development of Italy.

Therefore, the challenge to develop factual legislative instruments appropriate to support their development and to fulfil the required reforms of the Confidi system is actually be considered as an essential part of the global challenge of Italy to enhance national competitiveness in the next decades.

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[17] 'Socio sovventore' is a specific type of shareholder recently juridically introduced in some types of Italian cooperatives and with the main function of capitalization on the side of cooperatives and of perceiving of a profit on the side of 'socio sovventore'.

[18] Legislative Decree No 83/2012 and Legislative Decree No. 145/2013 have introduced the possibility for SMEs not listed on the Stock Exchange to capitalize themselves issuing mini- bonds exclusively addressed to or assured by qualified investors

[19] Legislative Decree No. 91/2014 has authorized to grant credit some additional institutions respecting established parameters, such as insurance agencies and the national insurance agency SACE (www.sace.it). Such institutions therefore are to become potential interlocutors of Confidi.

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FIGHTING POVERTY DURING THE GLOBAL ECONOMIC CRISIS (BASED ON FRANCE EXAMPLE)

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БОРЬБА С БЕДНОСТЬЮ В УСЛОВИЯХ МИРОВОГО ЭКОНОМИЧЕСКОГО КРИЗИСА (НА ПРИМЕРЕ ФРАНЦИИ)

Decades of the economic prosperity for many countries, including the most developed ones, have been replaced with a perceived decline in GDP and in the standard of living of the population accustomed to a certain lifestyle. Growing poverty caused social unrest, increasing the protest mood of the population. Together with the worsening aggressive foreign policy of a number of countries, primarily the United States and Great Britain, uncontrolled progression of events in this area represents a real threat to the national and economic security of many countries. Most governments of the world need to find measures of the regulatory impact on population's poverty. It is necessary to ensure not only their social efficiency, but also economic one. Extended experience gained in this field in France, traditionally has been focused on internal politics in working out redistributive mechanisms to avoid an excessive income gap between citizens. March, 3 2015 is the date when there was presented a new government program aimed at reducing poverty. Ambitious plans of the French government caused a huge public outcry in France and abroad, and turned out to be in the spotlight. The study of the proposed mechanisms does not allow us to evaluate the proposed plan to fight poverty only positively. However, the French experience, presented in this study, may be useful for government agencies, who develop and implement programs in this area, as well as for scientists and other experts. The analysis of existing problems and the presented overview of the proposed solutions is an impulse for further research in this area.

POVERTY; FIGHTING POVERTY; UNEMPLOYMENT; GLOBAL ECONOMIC CRISIS; FRANCE.

Десятилетия экономического процветания многих стран мира, в том числе самых развитых, сменились ощутимым снижением объемов ВВП и уровня жизни населения, привыкшего к определенному образу жизни. Рост бедности вызвал нарастание социальной напряженности, усиление протестного настроения со стороны граждан. В совокупности с обострением агрессивности внешней политики ряда государств, прежде всего США и Великобритании, неконтролируемое развитие событий в этой области представляет реальную угрозу национальной и экономической безопасности многих стран. Правительства большинства стран мира нуждаются в поиске мер регулирующего воздействия на уровень бедности населения. Необходимо обеспечить не только их социальную эффективность, но и экономическую. Богатый опыт в этой области накоплен во Франции, традиционно ориентированной во внутренней политике на выработку перераспределительных механизмов с целью устранения чрезмерного разрыва в доходах граждан. 3 марта 2015 г. была представлена новая государственная программа, направленная на снижение бедности. Амбициозные планы французского правительства вызвали широкий общественный резонанс во Франции и за ее пределами, оказались в центре обсуждения. Исследование предложенных механизмов не позволяет однозначно оценить предлагаемый план борьбы с бедностью только положительно. Вместе с тем французский опыт, емко изложенный в настоящем исследовании, может быть полезен для органов государственной власти, разрабатывающих и реализующих программы в этой области, а также ученым и иным профильным специалистам. Анализ существующих проблем и представленный обзор предложенных решений представляют собой импульс для дальнейших исследований в этой области.

БЕДНОСТЬ; БОРЬБА С БЕДНОСТЬЮ; БЕЗРАБОТИЦА; МИРОВОЙ ЭКОНОМИЧЕСКИЙ КРИЗИС; ФРАНЦИЯ.

Introduction. After the global financial and economic crisis had broken out in the so-called «developed» countries in 2008, it abruptly led to increased poverty. France has been one of the most developed countries in the world over the past 30 years from the 1980s., its welfare has been continuously growing. The trend has significantly changed with the global financial

and economic crisis in 2008 [39, p. 94]. Researchers and experts ask: what are the long-term social and economic consequences of this process? The main problem for the government became an unemployment surge. According to Eurostat, there were 24,850,000 unemployed in the European Union in July 2014 [14].

During the crisis and shrinking resources, unemployment − the main «engine» of poverty − becomes long-term [36]. In March 2015 the total number of the unemployed in France reached 5.2 million people. However, this number was determined with the method different from the method used by Eurostat specialists. What was taken into account is the unemployed of category A (a complete lack of work), B and C categories (part-time work, temporary work). If to consider citizens enrolled in educational programs, those who will soon enter the labor market, the total number of the unemployed is even higher − 5.9 million people on the mainland France territory [18]. In October 2014 2,000,000 French people lived on the amount of less than 651 euros per month, 3.6 million French people had constant problems with housing, 3.5 million people received food support [21]. At that time, the poverty threshold was set at 987 euros per month [33].

France tends to share «visible» poverty (people who are homeless and sleep on streets or in their cars, rummage through trash cans) and «invisible» (people who are unable to survive without food supply, and those who are forced to choose between food and heat, and those who are forced to spend the majority of their income on medicine and treatment) [31].

March 3, 2015 in Paris, French Prime Minister Manuel Valls presented a new ambitious government plan to reduce poverty.

The aim of the research is to study the regulatory impact of public authorities in France on the poverty level in the crisis and post-crisis development.

The object of the study is the policy of the French government, aimed at reducing poverty. The subject of the problem is declining living standards and the increasing poverty among the French population, as well as more active involvement of French citizens with incomes below the low-income poverty threshold in work and social activities.

Methods. During the study the authors used texts of programs, press releases, official statement posted on the website of France's state authorities: the official portal of the French Prime Minister, the portal for French citizens of e-public services, the Ministry of Social Welfare, Health and Women's Rights (Ministère des Affaires sociales, de la Santé et des Droits des femmes), General Welfare Inspectorate (Inspection Générale des Affaires Sociales), the Bank of France (La Banque de France), the Senate (Sénat),

Scientific articles and statistical reports of INSEE employees (Institut national de la statistique et des etudes économiques) allowed to specify the current trends and expand the idea of the phenomenon under study.

We studied materials of the French national news agencies: «Atlantico», «France Info».

The comparison of different points of view, the analysis of strengths and weaknesses of new anti-poverty program materials was made due to the contribution of the largest national media in France: «Le Monde», «Les Échos», «Le Figaro», «Libération», «Le Parisien», «Alternatives Economiques», «Radio France International», «L'Express».

All French-speaking primary sources were translated by authors themselves.

Results. Total instability caused by the ongoing global economic crisis, the decline in living standards of the population as a whole, rising unemployment forced the French government to take measures to fight the poverty rate, which declined steadily from 1996 to 2004, and then until March 2015, the time of this article preparation, the steady increase also became marked [37]. Since 2004, the annual increase in the number of French citizens living below the poverty line was: for the period from 2004 to 2010 the number had increased to 1,235 thousand people, reaching 8,617,000 [28]. However, as the experts of the European Commission noticed, with the onset of the crisis in France, there is a decrease in the level of differentiation of citizens' incomes [3], which can be explained by active redistributive policies of the country government.

Facing the economic and social crisis has a negative impact on the French society; poverty reduction plan materializes the nation efforts to help everyone to improve their living conditions.

The aim is to strengthen equality and fraternity of the republic and social cohesion [26]. At the highest level the French government emphasizes that in coming years the fight against poverty will be one of the key areas of the country's domestic policy. [9]

The most important measure of the program to fight poverty will be the «Premium activities» (prime d'activité) [19]. It will replace the currently existing mechanism to support people who are regarded as the category of the poor, called «Solidarity labor payment» (Le Revenu de solidarité active − Le RSA). Le RSA gives people with no income or insufficient incomes guarantees of the minimum income (taking into account the household structure) [32] and other social payments. Earlier, the French government had developed methodology that allows taking into account different life situations. They established clear criteria for those who can be qualified for payment. Particular attention was paid to single citizens (parent isolé), who include unmarried, divorced, living separately, widows and widowers who have one or more dependent children or pregnant women [5]. They were guaranteed an increased level of «Solidarity labor payments».

From January 1, 2016 poor workers (les travailleurs pauvres) can supplement their earnings with the «Premium activities». This monthly social assistance, the amount of which will depend on the personal income, according to the Prime Minister Manuel Valls words, will support both the purchasing power of citizens with low incomes and encourage them to work harder. In contrast to the pre-existing support systems, it will include young people, who enter the labor market for the first time, and they are forced to sign dubious employment contracts that violate their rights [19]. The key difference of the «Premium activities» from «Solidarity labor payments» is that they involve not only social welfare payment, but wage supplements to the minimum, hereby requiring additional support and will have a strong incentive to find a job. In this case, inadequate remuneration will no longer be a stratification factor of the French society. According to the Prime Minister of France, after the introduction of new rules for receiving social assistance from the state there will be 8 million applicants (against 7 million at present) [34].

The size of the «Premium activities» is discussed in the French Parliament. According to preliminary estimates, the maximum payment should reach 215 euros per month. However, a group of associations for the fight against poverty «Alarm» (Alerte) insists on increasing the upper limit up to 250 euros [34].

A still debatable issue is which of young people aged from 18 to 25 years old will be able to qualify for the «Premium activities.» According to the report of one of the developers of the draft law, the program will benefit 300,000 young people. However, the government intends to review its approach if a young Frenchman (Frenchwoman) lives with their parents, there should be evaluated not only the personal income of the applicant, but also the overall level of the household income. In this case, the number of beneficiaries will be reduced to 200,000 people. [7]

A total of from 4 to 5 million French people earning less than 1,400 euros per month will be recipients of the «Premium activities». The French government also promises to simplify the rules for obtaining the «Premium activities» in comparison with the pre-existing procedure of the «Solidarity labor payments» registration, which, due to the complexity of administrative procedures, left one third of eligible citizens out from the program of social guarantees. The roadmap of the new program includes 48 specific measures, which are aimed primarily at helping single-parent families and citizens being unemployed for a long period of time.

2 billion euros are allocated additionally for the program. These resources will enable the government to fulfill all additional commitments, in particular, to increase the amount of «Solidarity labor payments» by 10 %. It is valid until December 31, 2015. On the other hand, it will introduce a new principle of life in the implementation of the social policy in France: support [26].

One more innovation will be the appearance of the activity «La généralisation du tiers payant», aimed to facilitate access to medical care. The above said innovation has caused a storm of protest and strikes among French health workers [see. E.g, 2; 4], because «tiers payant» − is a way of social security, which allows citizens not to incur any costs connected with obtaining medical, pharmaceutical services and hospital services,

other than a «pass on visiting a specialist» (le ticket modérateur) [38]. That is, if a citizen does not ask for help in health care, in fact, now he has no mandatory medical expenses to be borne. The «Pass on visiting a specialist» implies partial compensation of expenses incurred by a citizen for a doctor's visit by the insurance company (l'Assurance Maladie). For example, a single doctor's consultation costs 22 euros, the insurer will return the citizen 70 % (15.4 euros) of this amount, but keeps a 1 euro fixed fee. The total compensation amounts to 14.4 euros [20]. The size of the refund may vary depending on various factors.

In general, the health care reform, which is expected to increase the availability of health services for the population, significantly restricts the rights of health workers themselves, as well as the ability to earn. This led to strikes and dozens of thousands of people ⸺ mostly health workers ⸺ took to the streets of Paris to protest on 15 March 2015 [13]. French citizens are particularly concerned about strikes of Emergency Medical service Providers [25].

In March 2015 every seventh French household «is living» below the poverty line; one in five children is at risk due to the situation of poverty. Among people who are in a difficult situation, a high proportion work for low wages. This refers especially to women who are single parents: every third woman has the income below the low-income poverty threshold (less than 960 euros per month) [26]. A significant number of French people suffer serious difficulties at the end of every month. Citizens living alone among the poor feel humiliated and are worried that their children will never be able to defeat poverty. According to UNICEF, by 2012 compared to 2008, the number of poor children in France increased by 440 thousand [24]. The total number of French children living below the poverty line is up to 3 million [27]. These children are poorly nourished, they do not have the opportunity to play sports and get additional development in cultural institutions. The decline resulting from the impact of the crisis, provokes a long downward trend for them [27]. As a result, every year 150 thousand students graduate from school without a diploma. UNICEF Employees dealing with the in-depth study of the social policy, have come to a depressing conclusion that France, as well as other «developed» countries are not economically interested in helping children and young people to overcome difficult life situations [27].

We can not say that the situation is complicated only in France. In many «developed» countries, the level of child poverty has dramatically increased. According to scholars, the growth of child poverty is caused by negative manifestations of the global financial and economic crisis [11]. Recent studies show that in some developed countries, including France, governments are not able to solve the child poverty problem. 41 richest countries have 76.5 million children in poverty. This growth is explained by the constant degradation of family relations, primarily due to job loss or ill-considered actions of the authorities. The situation is particularly difficult in Greece: in the period from 2008 to 2012 child poverty has tripled [11]. However, 18 out of 41 «developed» countries and governments find means to withstand the crisis, which leads to child poverty reduction. This occurs in Chile, Finland, Norway, Poland, Slovakia. According to foreign researchers, it proves the existence of effective mechanisms. The priority for other coiuntries is to be active in searching for and implementing such mechanisms. The problem of young people is also considered in this perspective: in the European Union 7.5 million young people (which is comparable with the Swiss population) aged from 15 to 24 years old never study and never work. From 2008 to 2014 their number increased by 1 million people [11].

Obviously, not only children and adolescents are exposed to poverty. The root cause is a decrease in the income of their parents or custodial parents. With the onset of the global financial and economic crisis, the general trend of poverty in France grabs more and more attention to this issue. Thus, in three years from 2008 to 2011 the total number of people to become «poor» was 900 thousand people. The total number of people with incomes below the subsistence level was in 2011 ⸺ 8.7 million people (14.3 % of the population) [1]. Poverty threshold in the period amounted to 977 euros per month.

The dynamics of poverty in France is due to three factors: labor market (unemployment); family structure (number of divorces); migration (migration which increases the share of the poor) [1]. The poorest residents of France are migrants and refugees from southern Sahara, Maghreb,

Eastern Europe [31]. They are not necessarily citizens, but their number from year to year, as well as problems related to them increase. With the low-income poverty threshold of 977 euros per month, they often live on 166 euros per month.

What is important is an active life position of a person below the poverty line: there are studies which prove that if a person takes active measures, a period of poverty reduction does not last longer than 3 years. There are two basic «channels» to overcome poverty: family support and employment [1].

The established system of redistribution is actively criticized by fellow citizens [26], they consider it is necessary for the French government to conduct a more active policy in fighting poverty.

A major concern is the problem of the homeless: the global economic crisis, falling incomes, a significant portion of the population has difficulties renting property. Despite the creation of social housing units, in 2012 — 102,728, and in 2013 — 117,065 units of social housing, the deficit remains significant. The new plan offered to introduce annually no less than 150,000 units of social housing. The main difficulty is that not all social housing in France is constant [24]. A disadvantage of the «control by thermometer» (la gestion au thermomètre) is the annual spring eviction of 11—13 thousand households involving law enforcement bodies[29]. With cold weather the authorities of French departments provide homeless with social housing [35]. However, at the end of winter when the temperature is high, they are trying to evict people on the street.

Management of the social system in France is too complicated, and generates social exclusion of many citizens, as well as useless and/or excessive costs [8]. The government's plan to fight poverty aims to simplify many aspects.

According to experts, the central element of the state social management system in France should be departments (the territory of mainland France is composed of 22 regions, which are divided into 96 departments — added by the Authors). Accordingly, it is necessary to reconsider their role in the economic and social development of France, to define the boundaries of their responsibility, to add them powers [15]. However, before starting a new public administration

reform, experts believe, it is important to find answers to the following questions [15]:
— Identify sources of the compensation for the new responsibilities of the departments;
— Find a balance between the social policies at the national level and social policy at the local level;
— Eliminate duplicate reference (avoiding situations where various authorities/departments send each other orders, trying to pass the buck for some work).

Rising unemployment in France in the context of the global financial and economic crisis has hit particularly hard poor citizens and citizens with low qualifications. The level of youth unemployment in the third quarter of 2014 was 23.7 % [24], which forces the government to develop urgent measures to facilitate the return of lost jobs. After the current President Francois Hollande (François Hollande) came to power, the instability in the French society is growing ominously: number of unemployed has reached the unprecedented magnitude — more than 600 thousand people in March 2015. In spite of all the authorities' efforts, the unemployment has had a steady growth since 2012 [30].

In the global financial and economic crisis the availability of banking services for many citizens is greatly reduced. The French government pays special attention to this issue. Under a special study [16] there were identified the most vulnerable groups: recipients of social benefits; job seekers; citizens with health problems; persons with disabilities; single-parent families; young people; workers who do not have full employment contract (working part-time or temporary jobs). The risk group includes the middle class; their financial problems may be due to the possibility of personal turmoil (divorce, job loss, death, etc.). All of them have the potential to be blacklisted by banks, they are excluded from the scope of banking services (l'exclusion bancaire). The exclusion from banking services is understood as «the process by which a person gets into difficulty gaining access to banking services, he loses the ability to lead a normal everyday life» [16].

In 2009 31 % of households was classified as poor, they have at least 1 loan. Mostly they take consumer loans in banks. Car loans do not exceed 8 %, mortgages — 6 % [17, p. 67]. According to the sociological research, 17 % of the received loans (among the poor) often or occasionally are

not to be repaid; another 17 % constantly experience such difficulties; the majority of borrowers – and they do it – try to repay the loan properly [17, p. 69]. Citizens who find themselves in difficult situations, having difficulty repaying the loan, can file a special appeal, which is considered by the Bank of France (Banque de France). Family and social economy advisers (conseillèr en économie sociale et familiale) interact with such citizens and help to develop and implement an individual approach to aid, judging by the response from higher authorities [6]. This measure has been much appreciated by French citizens, because thanks to it, for example, living alone the French do not feel alone in trouble.

In general, according to the study realized under the French Senate order, despite the impressive economic progress of the country, from 500 thousand up to 1 million citizens lack the opportunity to be integrated into the banking environment. It refers not only to the citizens recorded into the «black list» by banking institutions. Most of the potential representatives of this group voluntarily refrain from applying for the provision of services, obviously expecting failure [22]. The number of records on loans debts transferred to the Bank of France credit organizations at the moment is about 173 thousand applications, and they increase annually by about 6.5 %. Some borrowers who find themselves in a difficult situation, sent an appeal to the French bank. If we add to them those who do not send the applications, but have problems with the loan payment, the total number of citizens under the pressure of an excessively high level of debt will be 6 million [22]. The increase in the excessive debt within the global financial and economic crisis is a factor that seriously influences the well-being of the country's population, which is forced to refer to revolving credit services (credit revolving) and borrows money at an increasingly high interest (from 16 to 19.85 % per annum). In the short term such citizens accumulate heavy debts. Unfortunately, the French legislation has not kept up with in this case, the market and the situation is not properly regulated.

Particular attention of the French society is given to a problem of elderly women who live alone. For a number of reasons the work record of women is interrupted: pregnancy, parenting, part-time employment. As a result, a lower level of income causes reduced pension. As a rule, the higher pension of an elderly spouse compensates this deficiency, but if left alone older women literally are in the situation of hopeless poverty, and because of their age and health problems they can not work in order to obtain an additional income [33].

Conclusion. The study of regulatory impact of the French public authorities on the poverty level in the crisis and post-crisis development can lead to the following conclusions:

1) France has reached such a high level of the economic development that during the ongoing global economic crisis can afford to declare its intention to allocate significant funds to support the poorest of the poor. At present the Russian Federation is hardly capable of allocating a similar amount to reduce poverty. Moreover, a more detailed study of French Government policy documents shows that the increase in the financial burden is not critical for the French budget due to targeting financial flows. This experience is useful for Russia when searching for opportunities to spend government funds more efficiently in order to fight against poverty.

2) The official documents do not answer the question how cost-effectiveness of interventions will be assessed. The stated key objectives such as respect for equality and fraternity seem to be excessively declarative.

3) In the aggravating global economic environment the number of valid reasons behind the French government to provide additional resources, the value of which is not so obvious, according to the authors, is a necessity to face retribution for the misguided immigration policy. In particular, France has actively supported the overthrow of the Gaddafi regime in Libya which restrained the flow of migrants to this country from North Africa. Unfortunately, due to rising tension in the international environment, the armed conflict in Ukraine supported by economically developed countries of Western Europe and North America, the Russian Federation was faced with a massive entry of Ukrainian citizens fleeing from the civil war horrors into the country. Hundreds of thousands of refugees is a huge number. Most of them are in dire need of social support measures from the state authorities and local governments of the Russian Federation. No doubt, this situation aggravates a difficult poverty problem in our country. In this regard, further research of French government approaches to solve the

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North Africa refugee problems — their flow swept France after the Gaddafi regime overthrow in Libya — is necessary.

4) Great attention of statesmen, authorities of France is paid to the need to solve the problem of over-indebtedness of citizens and access to banking services. However, efficient and effective measures are not proposed. On the contrary, opportunities to «connect» the poor to banking services are being looked for. It is worth noting the development of informative measures (better awareness of consumers of banking services), establishment of observers' posts, intention to develop a charter aimed at the inclusion of citizens in the use of banking services. Could this be an effective measure? The state is likely to try to increase its influence, tracking more accurately the mood of citizens by increasing the frequency of their interaction with low-level officials. These measures are insufficient. On the other hand, efforts continue to «warm up» the economy due to the higher demand. It seems that the governments of all countries, including France, forget that the 2008 crisis resulted from the very high levels of consumer goods loans, when goods/services have long been consumed, and the money for them need to be earned in the future. This problem is urgent for the Russian Federation. Due to the inadequate legislation in the country, there are a lot of firms offering «quick money.» And their services are addressed primarily to citizens who cannot get a loan in major lending institutions at the less interest (because of unfair performance to repay the loan in the past or an insufficient income). In fact, all this has a negative impact on poverty: people in need receive money at higher interest rates, and it makes them even poorer. It adds the criminal growth through collection agencies to return the loan and high interest rates. This issue definitely needs to be the focus of the Russian Federation Government, especially in the global economic crisis.

5) The opposition forces «Association for People's Movement» (L'Union pour un mouvement populaire), headed by Nicolas Sarkozy, accused the government of speculation: The Fight Poverty Plan was published 3 weeks before a new election; it promises serious preferences to the segments of population with high probability of protest voting. In this case, a realistic assessment of the taken measures can be given only by the middle of 2016, and so far loud proclaiming has been only loud statements. According to the analysis of the opposition, the ruling Socialist Party pushes France deeper into debts: time when the country may select 4 billion Euros for EU only through borrowing additional funds; poverty reduction is possible only at the expense of increasing national debts. Following the elections in March 2015 in 96 departments of mainland France, the ruling «left» party has lost half of its departments, it was the fourth defeat in elections at various levels since it came to power in 2012 [12]. This election also marked a huge success of ultraradical right party «National Front» (Le Front national), headed by Marine Le Pen [10]. Obviously, it is caused by ineffective policies pursued by the current leadership of the French Republic. It must be remembered that such a worst-case scenario in terms of growing poverty will raise the protest mood, and it is especially dangerous for the Russian Federation in the global economic crisis. This results from the historically high level of the social and economic asymmetry in the development of Russian territories, wide areas with high concentration of the poor, which is a breeding ground for loosening the political situation in different regions. In this connection it makes sense for developing training programs aimed at solving the poverty problems in lagging regions and regions that are of great geopolitical importance.

6) Attempts to improve health services accessibility for the poor in France were in fact implemented at the expense of the social and economic status of doctors and managers of health care institutions, which are pushed off from management. Such a redistribution policy caused fierce resistance from health workers and led to ambulance strikes.

7) According to the existing methods, the poor will always be in France. Whatever struggle the French government declared, poverty would not disappear. Thus, according to 2012, if the poor are considered as people whose income is less than 50 % of the country's average income, the number of poor people will be at the level of 5 million; if the threshold is 60 % from the national average income, the number of such people will be 8.6 million [23]. When implementing any program, there will be always people with income less than 50 or 60 % of the average income in the country. It is necessary to find effective measures to enable people who are in difficult circumstances to integrate into the labor

market. The proposed measures for citizens' surcharge on monthly earnings from the French government do not impact the efficiency of work. Wages will have a fixed rate, so the approval of the stimulus material is dubious. According to the authors, it would be correct to implement educational programs for the poor that could improve their skills and enter the labor market with more confidence. To date, it is unclear how a simple distribution of money can make all citizens work better. Let us remember the anti-crisis policy pursued by subjects of the Russian Federation and municipalities in 2008–

2010. At the time great attention was paid to training the unemployed citizens who were on the verge of poverty. The federal government supported regions with serious financial resources. In fact, experts did not consider, what professions were needed for each specific territory. Citizens were educated, but failed to apply their skills and get a job, raise their income level. As a whole, the state program did not reach the declared goals. It is necessary to consider these problems in the future when searching for effective measures to reduce poverty in the Russian Federation.

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REACH THE TARGET USE OF RENEWABLE ENERGY AS A FACTOR OF IMPROVING ENERGY EFFICIENCY REGIONAL ECONOMY

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ДОСТИЖЕНИЕ ЦЕЛЕВЫХ ПОКАЗАТЕЛЕЙ ИСПОЛЬЗОВАНИЯ ВИЭ КАК ФАКТОР ПОВЫШЕНИЯ ЭНЕРГОЭФФЕКТИВНОСТИ РЕГИОНАЛЬНОЙ ЭКОНОМИКИ

The article presents the results of a study of the state energy saving policy in the area of development targets of renewable energy sources within the framework of the implementation of regional energy efficiency programs on the basis of analysis of the potential of the North-West Federal District of the Russian Federation. Research objectives: to conduct a qualitative analysis of the basic documents establishing requirements for the energy savings targets, based on the development of renewable energy sources to conduct a comparative analysis of the potential for the type of renewable energy sources and targets of their development on the example of the Northwest Federal District of Russia, to analyze factors influencing the development of renewable energy sources in the Russian Federation; to conduct a qualitative analysis of federal and regional energy saving policy regarding the development of renewable energy sources; suggest areas of efficient use of renewable energy sources in the current situation. To meet the challenges of research methods we used economic and statistical analysis, as well as regulatory and institutional method. The study systematized the factors affecting the development of renewable energy in our country in three directions: to meet the needs of the population, in entering the retail and the wholesale electricity market. We have shown the incompleteness of the requirements of the legal framework, excessive demands on the objects of renewable energy sources, the lack of effective mechanisms of state power generating facilities in the area of wholesale and retail electricity market. Proposed projects include the introduction of renewable energy sources in the federal targeted programs, the reduction of VAT on renewable energy equipment, its accelerated amortization, measures to strengthen the promotion of information renewable energy among households.

THE SUBJECT OF THE RUSSIAN FEDERATION; REGION; POWER MANAGEMENT; PROGRAM-TARGET METHOD OF MANAGEMENT; ENERGY SAVING PROGRAMS AND ENERGY EFFICIENCY; RENEWABLE ENERGY; REGIONAL ECONOMIES.

Представлены результаты исследования государственной политики энергосбережения в части развития целевых показателей возобновляемых источников энергии в рамках реализации региональных программ энергосбережения на основе анализа потенциала регионов Северо-Западного федерального округа РФ. Задачи исследования — провести качественный анализ основных документов, устанавливающих требования к целевым показателям энергосбережения на основе развития возобновляемых источников энергии, сравнительный анализ потенциала по видам возобновляемых источников энергии и целевых показателей их развития на примере регионов Северо-западного федерального округа РФ, анализ факторов, влияющих на развитие использования возобновляемых источников энергии в РФ, качественный анализ федеральной и региональной политики энергосбережения в части развития возобновляемых источников энергии; предложить направления развития эффективного использования возобновляемых источников энергии в текущей ситуации. Для решения задач исследования применены методы экономико-статистического анализа, а также нормативно-институциональный метод. По результатам исследования систематизированы факторы, негативно влияющие на развитие возобновляемых источников энергии в нашей стране по трем направлениям: для удовлетворения потребностей населения, при выходе на

розничный и на оптовый рынки электроэнергии. Показаны неполнота требований нормативно-правовой базы, завышенные требования к объектам возобновляемых источников энергии, отсутствие действенных механизмов господдержки генерирующих объектов в области оптового и розничного рынка электроэнергии. Предложены включение проектов внедрения возобновляемых источников энергии в федеральные целевые программы, снижение НДС на оборудование возобновляемых источников энергии, его ускоренная амортизация, усиление мер по информационному продвижению возобновляемых источников энергии среди домохозяйств.

СУБЪЕКТ РОССИЙСКОЙ ФЕДЕРАЦИИ; РЕГИОН; УПРАВЛЕНИЕ ЭНЕРГОСБЕРЕЖЕНИЕМ; ПРОГРАММНО-ЦЕЛЕВОЙ МЕТОД УПРАВЛЕНИЯ; ПРОГРАММА ЭНЕРГОСБЕРЕЖЕНИЯ И ПОВЫШЕНИЯ ЭНЕРГЕТИЧЕСКОЙ ЭФФЕКТИВНОСТИ; ВОЗОБНОВЛЯЕМЫЕ ИСТОЧНИКИ ЭНЕРГИИ; РЕГИОНАЛЬНАЯ ЭКОНОМИКА.

Introduction. The energy efficiency of the regional economy at the moment is determined by the successful implementation of relevant regional energy efficiency programs. The planning horizon of these programs in 2020.

This requires systematic solutions and their effective coordination from the federal government and regional authorities [20]. That, in turn, leads to the need of using a program-oriented approach in order to coordinate the activities of key players, plan the actions and make the necessary operational adjustments after evaluating the effectiveness of the implementation of the respective programs [5].

One of the areas of energy efficiency and modernization of the Russian economy is increasing the share of renewable energy sources (RES) and local fuels in the fuel and energy balance of the region and, consequently, the country as a whole. The 261-FZ includes requirements for mandatory inclusion of this target in the regional targeted energy efficiency programs, based on which, in particular, the effectiveness of the executive authorities will be assessed [4]. The targets are determined by the requirements [2].

Russia has vast reserves of renewable energy, the technical potential of about 24 billion tons of equivalent fuel (t e.f.) [3], which is several times higher than the consumption of fuel and energy resources of Russia and the economic potential of 320 million t e.f. [3], which is about 25 % of the annual domestic consumption of energy.

Since the capacities of the Russian energy sector are worn out, there is already an acute problem of updating them, which creates conditions in many cases for making a choice not in favor of the restoration of the pre-existing schemes of energy supply, but in favor of the implementation of new solutions aimed at increasing the use of renewable energy, taking into account regional specificities.

The aim and objectives of the research. The aim of the study is to conduct a qualitative analysis of the targets of renewable energy development in the regions of the Northwestern Federal District and state regulation measures in this direction.

In order to achieve this aim the following objectives have been set:

1. Conduct a qualitative analysis of the key documents that set requirements for the targets of energy-saving through the development of renewable energy sources;

2. Conduct a comparative analysis of the potential of renewable forms of energy and the targets of their development using the example of North-West regions;

3. Conduct an analysis of the factors affecting the development of the use of renewable energy in Russia.

4. Conduct a qualitative analysis of federal and regional energy-saving policy regarding renewable energy development.

5. Propose directions of efficient use of renewable energy in the current situation.

Research Methodology. To solve complex tasks, the authors of the study used a combination of methods of economic and statistical analysis and the regulatory and institutional analysis. We used actual statistics from a variety of domestic and foreign sources, as well as the base of normative documents of federal and regional levels.

The findings of the study. The regulatory framework requires the presence of mandatory target values in the regional energy-saving programs, which should reflect the values, including an increase in the number of objects used as a source of energy secondary energy resources (SER) and (or) the renewable energy sources (RES).

Consider these figures as an example of energy efficiency programs of the Northwestern regions of Russia (see Tab. 1).

The targets of energy saving programs NWFD regions [19] and some EU countries (within the framework of Directive 2009/28 / EC) (the volume of production of energy resources with the use of SER and RES)

The subject of the RF	Mesure	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
The Republic of Karelia	thousand t.e.f.	0.00	0.00	0.68	1.37	2.06	2.76	3.46	4.15	4.84	5.53	6.22	6.89	7.58	8.26
	%	*0.00*	*0.00*	*22.00*	*22.72*	*23.09*	*23.44*	*23.79*	*24.55*	*25.47*	*26.58*	*26.91*	*27.77*	*28.41*	*22.00*
Komi Republic	thousand t.e.f.	9.60	38.40	68.70	100.50	133.80	168.60	204.90	242.70	282.00	322.80	365.10	407.40	417.00	445.80
	%	*9.0*	*9.5*	*9.6*	*9.7*	*9.8*	*9.9*	*10.0*	*10.1*	*10.2*	*10.3*	*10.4*	*10.4*	*9.0*	*9.5*
Arkhangelsk Region	thousand t.e.f.	0.00	113.12	178.55	258.27	421.20	434.85	465.38	550.37	666.96	792.89	908.08	1031.05	1181.48	1298.56
	%	*13.76*	*14.63*	*14.55*	*15.20*	*15.30*	*16.83*	*18.18*	*19.09*	*20.62*	*22.27*	*24.05*	*25.97*	*28.31*	*30.59*
Vologda Region	thousand t.e.f.	0.00	0.00	0.00	0.00	0.08	0.12	0.15	0.21	0.25	0.25	0.25	0.25	0.25	0.29
	%	*7.5*	*8.6*	*10.1*	*8.6*	*9.0*	*14.8*	*18.3*	*20.8*	*23.8*	*23.8*	*23.8*	*23.8*	*23.8*	*24.5*
Murmansk Region	thousand t.e.f.	0.00	0.00	0.00	0.00	0.84	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.21	4.21
	%	*21.0*	*21.0*	*21.0*	*21.0*	*21.1*	*21.5*	*21.5*	*21.5*	*21.5*	*21.5*	*21.5*	*21.5*	*21.5*	*21.5*
Leningrad Region	thousand t.e.f.	0.00	0.00	0.00	0.00	30.00	62.00	94.00	126.00	158.00	192.00	227.00	263.00	298.00	336.00
	%	*0.00*	*0.00*	*0.00*	*0.00*	*0.3*	*0.7*	*1.0*	*1.3*	*1.4*	*1.6*	*1.8*	*2.1*	*2.4*	*2.7*
Novgorod Region	thousand t.e.f.	0.00	43.10	89.30	137.30	186.30	237.30	289.70	343.50	397.70	453.30	510.30	569.70	569.70	612.80
	%	*6.0*	*14.3*	*14.5*	*14.7*	*15.0*	*15.5*	*16.3*	*17.1*	*17.9*	*18.7*	*19.5*	*20.5*	*6.0*	*14.3*
Pskov Region	thousand t.e.f.	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03
	%	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.4*	*0.7*	*1.1*	*1.1*	*1.1*	*1.1*	*1.1*	*4.0*
Kaliningrad region	thousand t.e.f.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.56	9.56	9.56	9.56	9.56	9.56	141.56
	%			*0.23*	*0.22*	*0.16*	*0.15*	*0.15*	*0.29*	*0.46*	*0.46*	*0.46*	*0.46*	*0.46*	*1.83*
St. Petersburg	thousand t.e.f.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	%	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
TOTAL:	*thousand t.e.f.*	*9.60*	*185.02*	*142.61*	*160.21*	*276.84*	*135.56*	*151.96*	*213.90*	*247.83*	*257.02*	*250.18*	*261.34*	*195.72*	*359.72*
EU (2009/28/EC)	*%*	–	–	–	–	–	–	–	–	–	–	–	–	–	*20.00*
Germany	*%*	–	–	–	*10.20*	*10.80*	*11.40*	*12.10*	*12.70*	*13.40*	*14.10*	*15.50*	*16.30*	*17.10*	*18.70*
Great Britain	*%*	–	–	–	*3.00*	*3.70*	*4.30*	*4.80*	*5.70*	*6.60*	*7.90*	*9.40*	*11.1*	*12.90*	*15.00*
Sweden	*%*	–	–	–	–	*41.60*	*41.60*	*42.60*	*42.60*	*43.90*	*43.90*	*45.80*	*45.80*	*45.80*	*49.00*
Finland	*%*	–	–	–	–	–	–	–	–	–	–	–	–	–	*38.00*

Targets are set in real terms in t e.f., and a share of the total volume of consumed energy resources. The greatest increase in the share of SER and RES by 2020 at the level of 30.59 % is planned in the regional program of the Arkhangelsk Region. The lowest rate (0 %) is contained in the energy saving program of St. Petersburg.

It should be noted that this figure includes all types of SER and RES in the region, including those taking into account the production of electricity by hydroelectric power plants (HPP) with an installed capacity of over 25 MW. The actual value of the share of energy produced using renewable energy sources in the Russian Federation according to the Federal State Statistics Service for 2014 is 16.4 %, and at the level of the Northwestern Federal District it is 10.2 %. The study also examined the production of energy in the Northwest Federal District, excluding hydroelectric power produced above 25 MW. According to the Federal State

Statistics Service of the Russian Federation, in 2014, the figure was only 0.14 %, and at the level of the Northwestern Federal District it was 0.15 %.

What accounts for such low rates? Perhaps in these regions there is no proper capacities for SER and RES? To answer this question let us analyze the economic potential[1] of renewable energy in the Northwestern Federal District regions on the basis of statistical data [6].

Analysis of the data for 2012 showed that the regions in question have considerable economic potential for SER and RES, which reaches 27.32 % of the current energy consumption in the District (Tab. 2).

T a b l e 2

**The economic potential of RES
in the North-West regions in 2012**

The subject of the Russian Federation	Consumption[2] thousand t e.f.	The potential of RES, thousand t e.f.	The percentage of consumption
The Republic of Karelia	4670.84	1118.94	23.96
Komi Republic	10 275.17	1399.22	13.62
Arhangelsk region	9635.10	2632.75	27.32
Vologda Region	18 951.95	1220.12	6.44
Kaliningrad region	3 031.22	368.79	12.17
Leningrad region	18 195.54	1889.58	10.38
Murmansk region	7091.90	873.43	12.32
Novgorod region	2963.76	496.3	16.75
Pskov region	1822.72	428.33	23.50
St. Petersburg	20 010.74	1216.16	6.08
Total	96 648.93	11 643.62	12.05

[1] As part of the technical capacity, the conversion of which into useful used energy is economically feasible at this level of the prices of fossil fuel, heat and electricity, equipment, materials, transportation, labor, etc. [6].

[2] The authors' estimate of the gross energy consumption based on the data of Rosstat on «the energy intensity of GRP» and «GRP» of regions.

Structural analysis of the economic potential of SER and RES North-West regions has shown that the greatest potential is contained in the woodworking waste sector (up to 3075 thousand t e.f.), the largest contribution to this sector is from the Arkhangelsk Region (1263.5 thousand t e.f.) (see. Fig. 1). The greatest potential in physical terms is concentrated in the Arkhangelsk Region (2632.75 thousand t e.f., most of which is the potential of woodworking waste, i. e. 1263.5 thousand t e.f. [9]), the smallest is in the Pskov region (428.33 thousand t e.f., 139.44 t e.f. of which is the potential of biomass [9]). Despite the zero value of the target incorporated in the regional energy-saving program of St. Petersburg [20], the region has some potential for 1216.16 thousand t e.f. (most of which is the heat of sewage of 430 thousand t e.f., and the potential of biomass of 402.43 thousand t e.f. [9]) that with the proper development of this potential would be able to provide up to 6.08 % of the total needs of the city energy resources.

Considering the above target energy efficiency programs and taking into account the existing economic potential of SER and RES, we can conclude that these figures are too low and do not reflect all possibilities for the development of regions in this direction.

At the federal level a strategic target of increasing the relative volume of production and consumption of electrical energy using renewable energy sources (excluding hydro power plant of over 25 MW) from about 0.5 to 4.5 percent for the period until 2024 has been set in the Russian Energy Strategy to 2030[3].

In terms of analysis of the potential of the Northwestern Federal District, this goal is more consistent with the current situation. In these regions, it would be possible to substitute up to 3 % of the current electricity consumption through to the development of solar energy, small hydropower installations and wind energy. However, it should be noted that the strategic goal of reaching 4.5 per cent by 2024 does not look quite ambitious against the background of the strategic objectives of the European Union.

[3] Approved by Decree of the Government of the Russian Federation on November 13, 2009 № 1715-p.
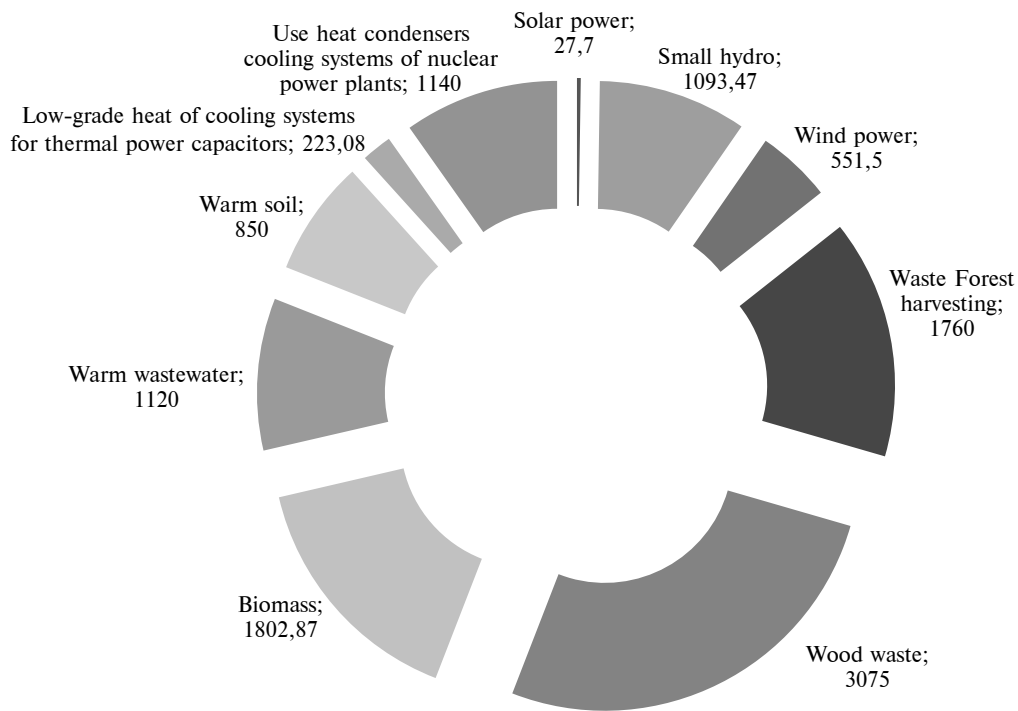
Fig. 1. Structure of the economic potential of RES of the Northwestern regions, thousand t e.f.

For example, in 2001, the Directive on renewable electricity (2001/77/EC) has set a target to increase by 2010 to 21 % the share of electricity produced from renewable energy sources in the EU. The goal set was potentially achievable, since in 1997 the proportion was 12.9 %. Following the objectives of Directive 2001/77/EC, the level rose to 641 TWh×h in 2010, of which 334 TWh×h was accounted for by hydropower, 155 TW×h by wind power, 123 TWh×h by biomass, 23 TWh×h by solar energy and 6 TW×h by geothermal energy. The share of green electricity in the EU is growing, having increased from 13.6 % in 2005 to 19.5 % in 2010 [15]. At the moment, the actual directive in the field of alternative energy in the EU is the Directive 2009/28/EC.

The authors then analyzed and studied the reasons for low use of water and energy resources and renewable energy sources in our country, calling into question the very possibility of achieving the specified target of the federal and regional strategic energy saving programs. The analysis is conducted in three areas: the introduction of SER and RES for the needs of the population (household use), the development of SER and RES in the retail and wholesale electricity markets.

The implementation of SER and RES for the needs of the population. Quite often a price comparison with other countries is used when justifying the low cost of energy (especially electricity) in the Russian Federation. To test this hypothesis, we have conducted a comparative analysis of the level of prices for electricity for households in Russian Federation and other countries. To ensure the comparability of the data, the assessment was made on the basis of purchasing power parities (PPP) [8]. The aggregated data are shown in Tab. 3.

Analyzing the results of the comparative analysis, we can see the following. The level of electricity prices for households in the areas of centralized power in the Russian Federation based on PPP is not much different from the price level in other countries. For example, the average price level in the Russian Federation ($ 173.43) is comparable to the price of New Zealand ($ 176.61), Luxembourg ($ 169.69) and Greece ($ 175.82) and above the price the United States, Switzerland, Norway and others. Price levels in the regions of the Northwest Federal District are also comparable with prices in the EU and the world, and in some cases are even higher. For example, the highest price for households among the regions of the Northwestern Federal District is in the Vologda region. ($ 288.76), which is higher than electricity prices in many countries (see Tab. 3).

Table 3

Electricity prices for households and industry at PPP in 2011 [15, 16, 18]

Country (regions of the Russian Federation)	Electricity prices for households at PPP, $/MWh	Electricity prices for industry at PPP, $/MWh	Ratio of prices for households and industry
Austria	230.79	–	–
Belgium	219.39	114.95	1.91
Denmark	280.51	78.96	3.55
Finland	162.24	86.31	1.88
Germany	316.94	141.59	2.24
Greece	175.82	127.55	1.38
Hungary	359.89	207.24	1.74
Japan	194.92	133.74	1.46
Korea	119.35	–	–
Luxembourg	169.69	90.37	1.88
Mexico	145.17	178.51	0.81
New Zealand	176.61	61.38	2.88
Norway	99.32	41.41	2.40
Spain	298.96	150.61	1.99
Sweden	180.47	75.77	2.38
Switzerland	132.03	78.19	1.69
Turkey	271.40	222.19	1.22
Great Britain	194.05	120.63	1.61
United States	117.84	69.57	1.69
For the centralized power supply zones			
Russia	173.43[4]	156.20[5]	1.11
Northwestern Federal District	193.66	–	–
The Republic of Karelia	113.54	–	–
Komi Republic	141.21	–	–
Arkhangelsk Region	167.15	–	–
Vologda Region	288.76	–	–
Kaliningrad Region	226.51	–	–
Leningrad Region	223.05	–	–
Murmansk Region	107.78	–	–
Novgorod Region	340.63	–	–
Pskov Region	245.53	–	–
Saint Petersburg	168.88	–	–
For The Decentralized (Isolated) Power Supply Zone [7]			
Tersko-Orlovskiy	1152.74	–	–
Kharlov Island	1072.05	–	–
Tsypnavolok	985.59	–	–
Pummanki	922.19	–	–
Kildin Island	887.61	–	–
Selo Chapoma	818.44	–	–

[4] The installed economically justified rate for electricity in homes with gas stoves (ruble), second half of 2011, according to the United interdepartmental statistical information system (EMISS);

[5] According to the Market Council NP for the first price zone (European Russia and Ural) of the «Comparative analysis of the level and structure of electricity prices for end-users in Europe and Russia 2010—2012» on the basis of the CFR and regional energy commissions.

Analysis results can be interpreted as follows: PPP level of electricity prices for households may not be a factor adversely affecting the level of RES in the region and the country as a whole.

However, at the moment about 65 % of the territory of the country [3] lies in the area of a *decentralized* power supply zone. These consumers deserve the greatest attention as subjects predisposed to the use of local RES. For example, consumers who live in the border, coastal and inland areas of the Kola Peninsula, where fuel delivery is significantly difficult, are forced to use petrol and diesel units with the power of 8−20 kW to provide for their energy needs [7]. Tab. 3 also shows the cost of electricity generated by diesel power plants in remote settlements on the coast of the Barents and White seas, which ranges from 818.44 to 1152.74 $/MW×h PPP. The price level is several times higher than similar rates for the regions of the Northwestern Federal District of centralized power, as well as prices in other countries. Thus, the price level for decentralized consumers can be a factor in stimulating the development of SER and RES.

Let us look at the energy-saving program of the Murmansk Region. Under this program [20], it is planned to establish in the settlements in the Terek and Lovozero districts (where installation is appropriate) the stand-alone automated diesel-wind power stations (ICE). The use of wind power generators paired with the diesel ones (VDES) can be an effective solution to reduce the costs of generating electricity from a diesel power plant (DES) and improving energy security for isolated consumers [4]. But there is still a low level of interest on the part of households in the use of renewable energy equipment, which is due primarily to its high costs [3], as well as the lack of effective mechanisms of state support.

The analysis also determined the ratio of the price of electricity for households and industry. Calculations show that in developed countries, the price level for the industry is lower than than the price level for the population. A similar ratio is observed in Russia, but the proportions are much lower. This suggests the continuation of cross-subsidization, in which industrial consumers actually pay part of the cost of the electricity consumption of the population and some other consumer groups equivalent to the population [12]. This factor can be considered as one having a negative impact on the level of water and energy resources and renewable energy sources in our country, as in the case of liquidation of cross-subsidizing the prices on electricity for households (population) will certainly grow which will serve as an incentive for them to move towards the SER and RES.

Another negative factor for the development of renewable energy in this group of consumers is the lack of adequate information on the benefits of renewable energy. Lack of demonstration experiments (including those supported by state programs) creates uncertainty and reduces the potential for the introduction of 'green' technologies.

Development of SER and RES in the retail electricity market. Within the framework of the existing rules of activity in the retail and wholesale electricity market, established in the legal acts of the federal level, the subjects of the retail electricity market can only be the objects of renewable energy with an installed capacity less than 25 MW. The basis of the small power in Russia is about 50 thousands of different power plants, with total capacity of 17 GW, or 8 % of the total installed capacity of power plants in Russia, working both in the power systems and autonomously. The total annual electricity generation at these stations reaches 5 % of the production of all stations of the country. [11] Since this direction of the energy industry is part of the sphere of natural monopolies which are regulated by the state, it is necessary to conduct a qualitative analysis of the federal and regional energy-saving policy (described in legal acts) as part of the development of renewable energy sources.

Paragraph 128 of Government Decree No. 442 of May 4, 2012 provides a procedure for the compulsory qualification of generation facilities based on renewable energy that grants them the right to sell electricity on the retail market. According to the rules established by the RF Government Decree No. 426 from 03.06.2008, the qualification function of generating facilities based on renewable energy is performed by the Market Council NP. Analysis of Regulation No. 24 of the Market Council NP on the qualifications of generating facilities revealed a high bureaucratization of the procedure, which reduces the initiative of organizations and investors in this direction.

Federal legislation establishes the requirement for state regulation of executive authorities of the Russian Federation on the basis of the guidelines approved by the Federal Tariff Service, the prices (rates) or marginal (minimum and (or) maximum) levels of prices (rates) for electric energy (power) produced on the basis of

renewable energy generation facilities qualified and purchased in order to compensate for losses in electrical power systems[6]. State regulation of prices (rates) in this area is especially important, because at the moment the level of prices for equipment and operation of renewable energy is much higher compared to traditional generation facilities. But at the moment there is no method of calculating prices (rates) for such property approved at the federal level.

In a competitive environment, due to a high level of rates for electricity produced from renewable energy sources, lack of transparency and incomplete legal acts, prescribing mandatory and conditions of contracts for the sale of 'green' energy, network companies may shy away from entering into the appropriate agreements. These circumstances will undoubtedly hamper the development of the industry and attracting investments for the construction of renewable energy facilities. [10]

Projects based on SER and RES should get tangible government support, including through the inclusion in regional development programs. Regional development programs are the responsibility of the regional bodies of power, which should include these items based on all the factors that operate in a region. It is not only a desire to reduce the cost of energy for consumers, but also the desire to improve the reliability of electricity supply, to solve environmental issues, to develop small and medium businesses, etc. [19]. At the same time, it is a deterrent, as, on the one hand, the regional authorities do not want to take on more responsibility, while on the other hand, the suppliers of traditional energy sources in the region are not interested in the development of renewable energy sources, and they may lobby for their for interests when regional regulations are enacted, thus putting pressure on regional authorities.

However, an early 2015 RF Government Decree of 23 January 2015 No. 47 makes changes to some acts of the Government of the Russian Federation, substantially contributing to promoting the use of renewable energy in the retail electricity markets. It establishes the procedure and the limits of long-term rate regulation parameters of RES facilities, the duty of purchasing electricity from qualified renewable energy generating facilities in order to compensate for losses on regulated rates set by the competent regional authorities and others.

To encourage the development of renewable energy facilities in isolated areas and non-price retail energy market the following measures may be proposed: the inclusion of RES projects in the federal target program, reduced VAT on equipment for the facilities of renewable energy, accelerated depreciation of equipment [11].

Development of SER and RES on the wholesale electricity market. According to the plan, the share of 'green' energy on the wholesale market in 2020 is expected to be 2.5 %, or about 6 GW. [19] As noted above, the objects of renewable energy with an installed capacity to 25 MW cannot be subjects of the wholesale market. Thus, only the development potential of the objects of renewable energy with a capacity of over 25 MW should be considered.

The Federal Law 'On Electric Power Industry' of November 4, 2007 has been amended to improve the competitiveness of renewable energy facilities. [1] Taking into account the indirect effects of the laws of Russian Federation, by-laws were adopted which contain guidelines on the qualification requirements of generating facilities, the provision of budget subsidies for technological connection, subsidizing interest rates on commercial loans for the development of renewable energy sources et al. [10]. Let us analyze these documents.

RF Government Decree of May 28, 2013 No. 861-p establishes the requirement of localization of the equipment which will be used in the construction of generating facilities of the wholesale market. For example, for power generation using wind up to 2017 there is an established requirement for the localization of the generating equipment at 40 %. Given the dramatically low level of production of renewable energy equipment in Russia, these requirements, in our opinion, are impracticable and making it difficult to achieve the set targets for the development of renewable energy in our country.

The procedure and terms for technological connection are established in paragraph 16[7]. The approximate period of 2 years (but not more than 4 years) is set for the applicants, the maximum capacity of the power units is no less than 670 kW[8]. This reduces the likelihood of implementing the proper amount of projects in construction of renewable energy.

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[6] On pricing in regulated prices (rates) in the electric power industry. Resolution of the Government of the Russian Federation of December 29, 2011 No. 1178.

[7] Approved by Decree of the Government of the Russian Federation of December 27, 2004, No. 861.

[8] Order of the Government of the Russian Federation on January 8, 2009 No. 1-p with the changes.

Factors that negatively affect the achievement of the targets of RES development in directions		
Meeting the needs of the population, including decentralized market	**The retail electricity market**	**The wholesale electricity market**
Cross-subsidization	The bureaucratization of the qualification of RES generation facilities	The complexity of the performance requirements for localization
High capital RES facilities	The lack of methods for calculating prices (rates)	Influence of the time limits for the tech. connection on commissioning RES objects
Low public awareness about the benefits of RES, including the lack of information from the state	Lobbying interests of suppliers of traditional energy sources	Membership in the Market Council NP entailing significant financial expenses
		The need for a guarantee from a member of the wholesale electricity market

Fig. 2. Systematization of the factors that negatively affect the achievement of the development RES targets

The support system for renewable energy by the wholesale power market was introduced in 2013. Government Decree No. 449 of 05/28/2013 defined the procedure for the selection of investment projects for the construction of renewable energy generation. Once a year, wind (WEC), solar (SES) power and small hydropower plants meeting the requirements for capital expenditures and containment equipment are selected by competition and are then given the right to sign the agreement to supply power (PDM), which guarantees a return on investment through increased payments [19]. The PDM RES is valid for 15 years, the target level of the rate of return is 12–14 % (14 % for the first two years and 12 % from the third year after the selection of the project). The obligations to purchase power supplied by renewable PDM are distributed among all consumers in the appropriate price zone. [11]

There is a strong demand for competition SES projects, as-the entire volume of output for the years 2015–2018 was sold out, but only 8.5 and 4.8 %, have been sold for WPP and small hydropower plants, respectively. The main obstacle for the participants was the requirements for localization of equipment, which has already been mentioned above, i. e., in fact, the lack of currently relevant equipment manufacturing in Russia.

There are additional requirements for such investment projects, adversely affecting the pace of implementation of renewable energy facilities. Responsibility for organizing and carrying out the specified selection procedure has been transferred to the Market Council NP. The Regulation of the Market Council NP No. 27 from 07.16.2013 'On carrying out the selection of investment projects' secured the conditions for participation in the competitive selection of RES projects, one of which was a requirement for membership in the Market Council NP, which implies the introduction of a one-time introductory membership fee in the amount of 1,000,000.00 rubles and payment of quarterly fees. For generating companies in 2014 this figure amounted to 1,091,000.00 rubles, which is equivalent to the proceeds from the sale of electricity on the wholesale market produced by a SES with an installed capacity of 100 kW at a peak in the development and in the climatic conditions of the Belgorod Region for more than 5 years. At the same time, this amount is the same for large nuclear and hydroelectric power plants, and small objects of alternative power [10].

Thus, it is possible to systematize factors that negatively affect the achievement of the targets RES development (Fig. 2).

Conclusions. An analysis of the current domestic and foreign statistical data from different sources of information and analysis of legal acts in the area of program-oriented power management and development of renewable energy:

1) formed a structured assessment of the potential of the Northwestern Federal District of the Russian Federation in the field of renewable energy;

2) proved the validity of targets due to their compliance with the terms of the economic potential of renewable energy regions of the Northwestern Federal District, taking into account the hydroelectric power production capacity of over 25 MW;

3) proved at the same time that these targets for energy efficiency programs are understated, if the energy generated by hydroelectric stations with a capacity over 25 MW is not taken into account;

4) showed that the PPP level of electricity prices for households in the Russian Federation is not low compared with other countries and cannot be a factor that affects the implementation of the targets of SER and RES;

5) showed that the development of renewable energy is especially important for the consumers of the isolated areas of power supply where prices are several times higher than the similar rates for the regions of centralized power, as well as prices in other countries;

6) revealed the incompleteness of the requirements of the legal framework, excessive demands on the objects of renewable energy (in particular the degree of localization), which is associated with the negative lobbying influence of natural monopolies, adhering to the traditional areas of generation.

All this, of course, negatively affects the level and pace of development of renewable energy sources in the Russian Federation, and, consequently, the possibility of achieving the specified targets of the respective energy efficiency programs. On the other hand, given the identified energy resources of the Russian Federation, a high development potential of renewable energy in our country and in the Northwestern Federal District may be noted.

High speed and quality for achieving the targets of renewable energy in the EU Member States can be explained by their desire to ensure the independence and energy security in view of the significant limitations of its own reserves of non-renewable energy sources within the framework of the EU general policy.

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ECONOMIC FEASIBILITY OF GEOTHERMAL HEAT PUMPS FOR HOUSING ESTATE HEATING

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ЭКОНОМИЧЕСКАЯ ЦЕЛЕСООБРАЗНОСТЬ ПРИМЕНЕНИЯ ГЕОТЕРМАЛЬНЫХ ТЕПЛОВЫХ НАСОСОВ ДЛЯ ТЕПЛОСНАБЖЕНИЯ ЖИЛЫХ КОМПЛЕКСОВ

Energy conservation is one of the most important strategic initiatives of the «Energy Strategy of Russia until 2030», approved by the order of the Russian Federation government No. 1715-r of November 13, 2009, as without its large-scale implementation the development of the Russian economy will be limited to energy and environmental factors. Therefore, it is necessary to use the international experience of energy efficient technologies, such as heat pump installations in the heat supply systems of residential buildings and the development of integrated energy-saving measures, to create and secure stable, highly efficient, uninterruptible power supply in Russia. The article, written by V. Linhartova, E. Sokolova and V. Sergeev, is devoted to the presented problem. It considers the existing district heating system in the Czech Republic and the Russian Federation, exemplified by two major cities − St. Petersburg and Prague. The authors identified similar and different features in climate, geography, political and economic situation, analyzed the economic feasibility and technological possibilities of transferring the residential complex, both existing and new, to their own power supply. In addition, the authors calculated the economic benefit from the use of low-grade heat in the heating system (heating, ventilation and hot water supply) of the residential complex through the use of geothermal heat pump systems. The article results into the conclusion that its is inappropriate to use low-grade heat recovery systems due to lower prices of the fuel source, and consequently the price of the consumed heat load. However, the authors, referring to the inevitable exhaustion of natural resources, are confident about the prospects of their research and are ready to continue investigations in this area.

GEOTHERMAL HEAT PUMP; INDICATORS OF ECONOMIC EVALUATION; HEATING SYSTEMS; DISTRICT HEATING; ECONOMIC ATTRACTIVENESS.

Энергосбережение одна из важнейших стратегических инициатив («Энергетическая стратегия России на период до 2030 года», утв. распоряж. Правительства РФ № 1715-р от 13.11.2009 г.), поскольку без ее масштабной реализации развитие экономики России будет ограничено энергетическими и экологическими факторами. Поэтому необходимо, опираясь на мировой опыт внедрения энергоэффективных технологий, таких как включение теплонасосных установок в состав систем теплоснабжения жилых зданий и развитие комплексных мер по энергосбережению, создавать и закреплять устойчивое, высокоразвитое, бесперебойное энергоснабжение в России. Рассмотрены существующие системы централизованного теплоснабжения в Чешской Республике и Российской Федерации на примере двух крупных городов − Санкт-Петербурга и Праги, выявлены их схожие черты и различия относительно географии, политической и экономической ситуации. Проанализированы экономическая целесообразность и техническая возможность перевода жилого комплекса, как существующего, так и нового, на собственное энергообеспечение. Подсчитан экономический эффект от использования на отопление, вентиляцию и горячее водоснабжение низкопотенциальной теплоты в системе теплоснабжения жилого комплекса с применением геотермальных теплонасосных установок. Сделан вывод о нецелесообразности использования систем утилизации низкопотенциального тепла в виду низких цен на исходное топливо, а соответственно и цен за потребленную тепловую нагрузку.

ГЕОТЕРМАЛЬНЫЙ ТЕПЛОВОЙ НАСОС; ПОКАЗАТЕЛИ ЭКОНОМИЧЕСКОЙ ОЦЕНКИ; СИСТЕМА ТЕПЛОСНАБЖЕНИЯ; ЦЕНТРАЛИЗОВАННОЕ ЭНЕРГОСНАБЖЕНИЕ; ЭКОНОМИЧЕСКАЯ ПРИВЛЕКАТЕЛЬНОСТЬ.

Heating and hot water preparation together with ventilation air preheating are basic energy consumers in dwellings. During their history, heating systems have undergone long development. Nowadays the main issue is how to use the primary sources as efficiently as possible in connection with environmental aspects and sustainable development. While using traditional primary sources, the population should consider that they are not something taken for granted, and they are scarce. It is considered, that the compensatory solutions with high technical and economic efficiency must be available.

The utilization of environmental and energy efficiency renewable sources will improve environmental conditions in cities, where traditional primary energy sources are burned and the air is polluted. According to Russian Prosecutor General's office, 53 % of the urban population lives in areas with high or very high level of air pollution [1]. The Air Pollution Index (API) in Saint Petersburg is a little less than 7, which means the city is on the boundary between high and extremely high air pollution. There is also a statement that industrial enterprises often do not install purifying equipment because the fine rate for exceeding emission limits is very low. For industrial enterprises it is more economical to pay the fine every year than modernize the purifying equipment. Its modernization is extremely slow. Poor air conditions can increase the number of asthma cases, worsen the situation with cardiovascular diseases and what is more − to lead to the rise in lung and bronchial diseases. Basically, it adversely affects children's health, weakens the immune system and leads to chronic respiratory and other diseases.

St. Petersburg and Prague are two large and beautiful, but quite different cities. Their location, weather, political system, social orientation − are not similar at all. Undoubtedly, all of these aspects affect different fields of people's private life, which dictates its own preferences in choosing living conditions.

Truly, innovations in the Russian Federation (RF) seem to be simple and everyday technologies for the Czech Republic (CR). The first reason is the delayed development of Russia. Since the fall of the Soviet Union until 2003, the country was in the doldrums, the industry stopped, many companies went bankrupt and many factories were closed. The equipment was morally and physically outdated, fundamentally new technologies were not offered, highly qualified personnel were not trained, and investments in the energy sector were insignificant.

In 2003, there was a rise in the electricity output, which was due to the increased demand. However, this resulted into new problems: a lack of generating capacity and their inefficient use, the complexity of the transmission to the consumer in connection with weak mains. According to the European Bank, radical restructuring of the industry with the purchase of new equipment for all power plants and the attraction of skilled workers were urgently needed for the Russian energy sector.

For more than 60 years CR has widely used heat pumps not only in individual heating circuits, but also centralized ones. Development and improvement of heat pump systems are most urgent issues of modern industry. The main areas of their application are different heating systems and efficiency improvement in industrial processes [2]. In all these cases, with their application people solve the problem of thermal resources energy saving. Heat pumps, placed on the combined heat and power plants (CHP) or large combustion plants and sewage treatment plants, show an excellent example of environmentally friendly, economical and technically expedient devices [3].

Another serious problem of the Russian industry is its high power consumption. The energy cost of the gross domestic product several times exceeds the global average. According to the statistics, a decline in the domestic demand for electricity will decrease with the introduction of less energy−intensive technologies and the modernization of fuel and energy complex as a whole.

This may be achieved by:
− Introduction of technologies with low payback period of 1.5 years;
− Creating the systems of economic incentives for energy saving (extra−budgetary funds, demonstration areas, etc.);
− Training targeted energy efficiency programs at the federal, regional and municipal levels aimed at the use of alternative energy sources (development of independent power supply, development of control systems for energy consumption, etc.) [4].

According to the World Energy Council (WEC) in 2020, all developed countries will receive 75 % of the thermal energy in the form of heating and hot domestic water preparation from geothermal stations. This prediction is confirmed successfully. Nowadays, the world has about

20 million of heat pumps with various capacities. Therefore, for example, in Sweden, which is the undisputed leader in a number of the used heat pumps, the total amount of heat generated by the heat pump is more than 50 %. Only in Stockholm this figure is close to 15 %. However, in RF heat pumps did not become popular because of a lack of technically implemented and economically justified schemes for the utilization of low−grade heat from large sources [5].

The major difference between RF and CR is the approach to energy saving and efficiency. In Prague, central heating plants are modernized gradually. The energetic concept of the European Union EU has a goal to use renewable energy sources instead of the usual ones, to reduce air pollution, prevent different diseases, etc. The CHPs shall meet these regulations. If they do not modernize their equipment and reduce the heat loses, the price of heat will become too high and consumers will disconnect from the district heating systems.

European regulations on the overall efficiency of buildings force Member States of the European Union to take measures in order to reduce energy consumption and carbon dioxide emissions. The decision on energy conservation (EnEV) marked the transformation of the national law in 2002. The first construction and civil engineering heating requirements for buildings began to be considered as a single complex. The maximum state support was provided to the systems, using energy from the environment, as well as installations with a high degree of heat recovery.

However, in CR the price of heat is very different for each city (Tab. 1). The exchange rate in calculation is 27 CZK for 1 EURO. As a result, some consumers changed the central heating system to the local one; however, many people continue to use it.

T a b l e 1

Prices of heat in different cities in Czech Republic [6]

CITY	PRICE OF HEAT Euro/GJ, 2014	MAIN FUEL
Pardubice	15,9	brown coal
Pilsen	18,2	brown coal
Ostrava	19,8	black coal
Prague	21,3	natural gas and black coal
Olomouc	22,2	black and brown coal
Brno	24,7	natural gas

In RF, there are a lot of debates about the necessity of renewable energy sector development, but practically there are no actions. Only nowadays, the country tries to transit to the renewable energy sources (RES) due to the systemic approach to energy efficiency. It includes measures to improve the efficiency of fuel and energy resources, the establishment of the regulatory framework and information technology, also all sorts of methods and criteria for evaluating the effectiveness of energy saving, energy-saving measures both in industry and in housing and communal services, energy audits and new energy technologies.

According to the statistics, the centralized heating system provides heat for about 75 % of all consumers in RF. However, about 35 % of the required heat is provided by heat supply systems, systems in which heat sources combine heat and power (CHP) of various capacities. District heating systems have great importance for the organization of rational energy in the country, because they are the most advanced technological means of electric and thermal energy and one of the main ways to reduce fuel consumption for these types of energy. In total, a large cogeneration system produces approximately 6.28 PJ/year, of which 47.5 % for solid fuels, 40.7 % for gas and 11.8 % for liquid fuels [6].

Power and heating plants in CR produced 66.14 % of the total heat production. There were 1.48 million households where the heat energy from the district heating system was delivered. In order to produce the energy in central heating plants 68 % of the primary energy is originated in CR, the rest of the energy needs to be bought. The install heat power input on boilers in CHPs was 46 653 MW in 2012. The install electricity power input on generators in CHPs was 15 607 MW in 2012 [7].

The original district heating piping systems in CR distributed the heat by hot steam. The replacement of the steam piping by the hot water piping system started approximately in the year of 2000. The modernization takes place gradually from bigger cities to smaller ones. For example, in 2014 a 18.5 km of old piping was replaced [8].

In RF, on the contrary, due to the obsolescence of domestic heating systems (Tab. 2), rough operation, long inefficient heat supply and regulation, the passage of the peak load, the number of combined heat and power CHP is reduced.

T a b l e 2

Centralized CHP in St. Petersburg [9]

Station number	Date of input	The type and brand of equipment	Year of achieving economic life	Year achieving individual resources based on extension
Turbines				
1	31.12.1929	«P-2/12/1.0»	1964	
Steam boilers				
1	31.12.1912	«B-W»	1942	2015
2	31.12.1912	«B-W»	1942	2013
3	31.12.1914	«B-W»	1944	2016
4	31.12.1912	«B-W»	1942	2016
5	31.12.1916	«B-W»	1946	2016
6	31.12.1916	«B-W»	1946	2014

Obviously, that introduction of new technologies at facilities with outdated equipment, which has repeatedly been subjected to the repair, will be accompanied by the significant capital and operating costs, as well as the inability to ensure the reliable operation of the heat pump system in the case of failure of the obsolete equipment.

Generally, there are no efficiency demands for heat pumps in RF, though it could be a great breakthrough to use them on the existing CHP and hereby to renew the entire energy system. No national standards, which require minimal coefficient of performance (COP) or seasonal performance factor (SPF), mandatory certification of design and installation organizations, whose activities are connected with heat pumps, minor fines for extra emissions; finally there are no government grants for the transition from liquid, gaseous fuels and direct electric heating to the use of heat pumps, which stimulates many Czech companies to develop these technologies.

The next reason for differences is the cost of primary energy. Everybody knows that RF has the largest gas reserves. The price for natural gas from the district heating network is 0.132 Euros.m^{-3} for St. Petersburg; in Prague, to compare, this figure is about 0.570 Euros.m^{-3} (2014). Probably, the relatively low cost and wide distribution of gaseous fuels resulted in a low demand for heat pumps. Earlier, the scientist Udrits proved that at a low cost of fuel the cost of electricity reduces, and in such circumstances it is advantageous to carry out a direct electric heating. European countries have to buy fossil fuels abroad, which leads to the search for alternative sources and development of new technologies.

The heat pump can be used for heating, air-conditioning (ventilation) and hot domestic water preparation. As a source of low-grade heat, engineers use air, water, soil heat, waste heat, and the heat from solar collectors. The main condition is to heat working fluid with their help in order to get the desired temperature from the condenser, the level the temperature for RF and CR is different. In the first case, according to the standards, a temperature range of heat networks is 95/70 °C. In the second is 75/55 °C. That means that the sufficient temperature of 75 °C for the Czech heating system is suitable only for the underfloor heating system or air conditioning in Russia.

Considering technical conditions, efficiency and economic aspects in RF and CR, the most suitable is to consider heat from geothermal vertical loops as a renewable energy source. The heat from the ground will be a primary energy source for a brine-water heat pump. The calculation is handled with the replacement of a traditional non-renewable energy source by a renewable energy from the ground vertical loops combined with a heat pump.

The vertical loop of a ground source heat pump system has to be designed using a combination of loop well geometry, loop tube configuration and placement, grout thermal properties, and appropriate ground thermal characteristics, such as conductivity, diffusivity and average ground temperature during the year. The thermal performance of a vertical loop depends on a heat transfer between a borehole heat exchanger and the surrounding soil. The Construction of a heat pump loop includes drilling the vertical borehole into the ground, placement of the loop tube to the bottom of the vertical borehole with the grout tremie and grouting the vertical borehole from the bottom of the vertical borehole to the ground surface (Fig.1).
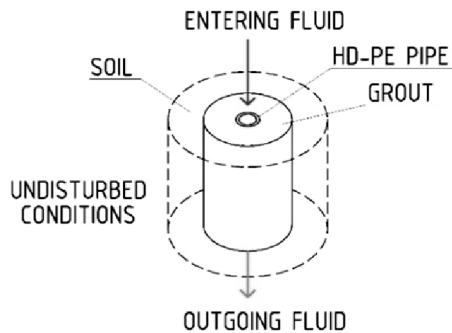
Fig.1. Scheme of the thermal model describing the thermal exchange between the refrigerant fluid and the ground [10]

Ground vertical loops should be designed as long-term sources of heat. The service life of a ground vertical loop should be longer than the service life of a heat pump, which is usually between 20 and 25 years. It should be possible to change a heat pump after its service life and use the existing vertical loop with a new heat pump. To ensure that the loop would work properly for a long period, it is necessary to enable the loop to regenerate. Whether ground temperatures can recover in summer will depend on the region's climate, soil conditions on the spot of the ground loop, and the size of the ground loop. In locations with low ground temperatures and a high annual heating demand, thermal imbalances are of large concern. To make sure, that the loop recovery during summer will be sufficient, it is good to use it as a source of energy for passive or active cooling. A Canadian study confirms that the most common household issues occur with poorly designed systems, which results in the thermal imbalance, where the soil cannot thermally recover.

The brine will be used as a coolant in boreholes. It is a solution of salt in water.

To ensure the efficiently optimal operation of a heat pump and its long service life, the required power input for heating and hot water preparation will be ensured by a cascade of heat pumps. The control system must be designed precisely to reach the optimal operational efficiency. Additional advantages of the heat pump cascade installation:

− At the lowest outside air temperatures the heat pumps will work at the maximum performance level and with the increase in the outside air temperature the heat pump's performance will decrease. In autumn and spring the heat pumps can be gradually disconnected from the system one by one;

− While one heat pump is out of order, there will be another one, which could cover the energy demand at least partly.

The calculations are made for a new highly-insulated building and for the existing building without modernization in Prague and in St. Petersburg. The housing estate is considered with approximately 500 apartments.

There have been made four variants of calculations:

A − Thermally insulated new building in Prague,

B − Existing building without modernization (1985 and older) in Prague,

C − Thermally insulated new building in St. Petersburg,

D − Existing building without modernization (1985 and older) in St. Petersburg.

The calculation of the annual heating demand is made according to the degree day method, standard [11]. Outdoor temperature is −12 °C in Prague and −26 °C in St. Petersburg. The average outdoor temperature is 4.3 °C in first case and −1.8 °C in the second. The average indoor temperature is 19 °C in Prague and 18 °C in St. Petersburg. The heating season in Prague accounts for 225 days and in St. Petersburg − 239. The annual heating demands are summarized in Tab. 3.

T a b l e 3

Annual heating demands

		PRAGUE		SAINT PETERSBURG	
		OPTION A	OPTION B	OPTION C	OPTION D
REGUIRED POWER INPUT FOR HEATING	W	350 000	1000 000	475 000	1500 000
DEGREE DAY METHOD	K.day	33075	3307.5	4732.2	4732.2
ANNUAL HEATING DEMAND	kWh.year^{-1}	761792	2048516	1042160	2613465

The annual heat demand for hot domestic water preparation is counted for 1000 residents according to the standard [12] for Prague and the standard [13] for St. Petersburg. The temperature of cold water in winter is 5 °C, in summer is 10 °C and the temperature of hot domestic water is 60 °C. The required amount of hot domestic water is 82 liter.person^{-1}.day^{-1} in Prague and 102 liter.person^{-1}.day^{-1} in St. Petersburg. The resulting annual heat demand for hot domestic water preparation is 2 563 295 kWh.year^{-1} in the first case and 2 381 418 kWh.year^{-1} in the second. The lower energy consumption in St. Petersburg results from the different calculation of heat losses on the circulation piping.

The calculations are made according to the soil parameters from Prague and St. Petersburg. The thermal parameters and dimensions of boreholes are presented in Tab. 4. The soil temperature in non-affected area (t_z) is considered to be 11 °C in Prague and 10 °C in St. Petersburg with the change of temperature + 3K/ 100 m depth. The temperatures in boreholes (t_v) are cogitated between −4 to +4 °C. The specific power of borehole (q_{Zl}) is calculated by formula 1. The average value of the specific

power of borehole in Prague is 43 W.m^{-1}, in St. Petersburg 70 W.m^{-1}.

$$q_{zi} = \frac{t_z - t_v}{(R_z)}. \qquad (1)$$

The use of alternative energy sources has limitations. Therefore, it is sometimes more efficient to use one type of the alternative energy supply combined with the conventional methods [14]. The bivalent source of energy is included in the project too. The utilization of heat from ground vertical loops by heat pumps is 70 % and the remaining 30 % is covered by a bivalent source. The bivalent source of energy uses heat from the district heating system. Resulting parameters are summarized in Tab. 5.

To check the temperatures calculated in the depth of boreholes, the actually measured temperature data is used. The temperatures in the sample borehole are measured in CR by the depth in 2013. They are in Fig. 2.

The energy demand for hot domestic water preparation has a preference over the heating demand. In addition, the four-pipe system is used [15]. The scheme of the system is in Fig. 3.

Table 4

Thermal parameters and dimensions of boreholes

	sign	Prague	St. Petersburg	units
THE THERMAL CONDUCTIVITY OF SOIL	λ_Z	1.9	3.1	W.m^{-1}.K^{-1}
DIAMETER OF THE AFFECTED AREA BY BOREHOLE	D_Z	4	4	m
THE BOREHORE RADIUS	d_V	0.1	0.1	m
THE PIPE RADIUS	DN	0.025	0.025	m
THERMAL RESISTANCE OF BOREHOLE	R_Z	0.309	0.189	m.K.W^{-1}

Table 5

Number and depth of boreholes

		Prague		St. Petersburg		units
		A	B	C	D	
REGUIRED POWER INPUT	HEAT PUMP	431.0	597.8	417.8	609.6	kW
	BIVALENT	184.7	256.2	179.1	261.2	kW
BOREHOLE LENGTH-TOTAL	l_W	10 095	14 002	5 997	8 750	m
NUMBER OF BOREHOLES	p	52	72	31	45	pieces
LENGHT OF 1 BOREHOLE	l_{each}	194	194	193	194	m
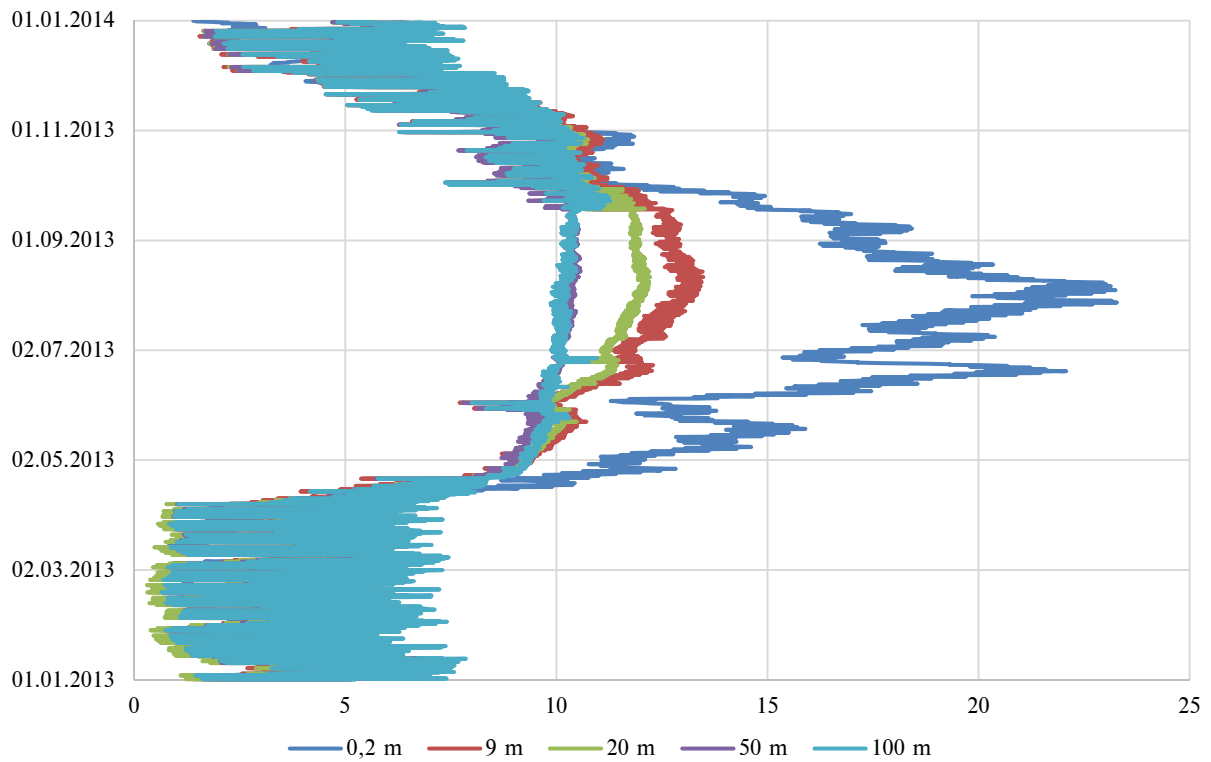
Fig. 2. The temperatures in the sample borehole measured in 2013
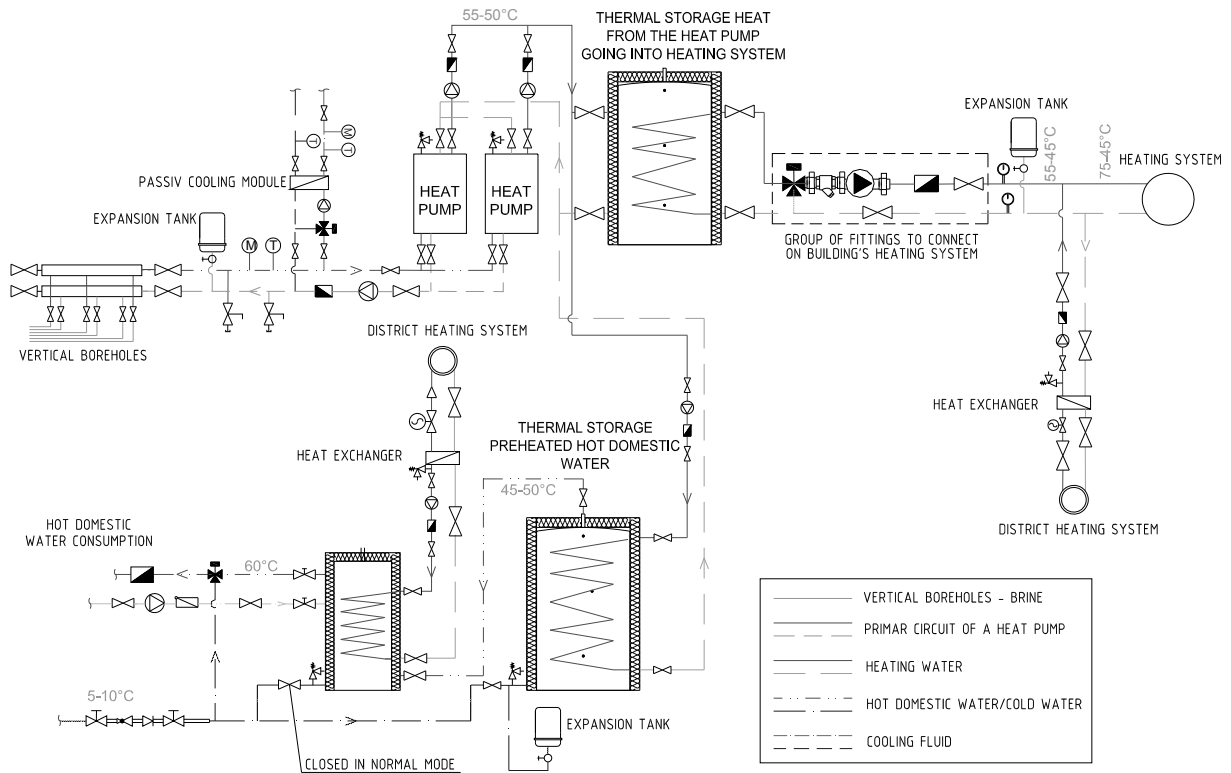
Fig.3. Connection scheme of heating sources
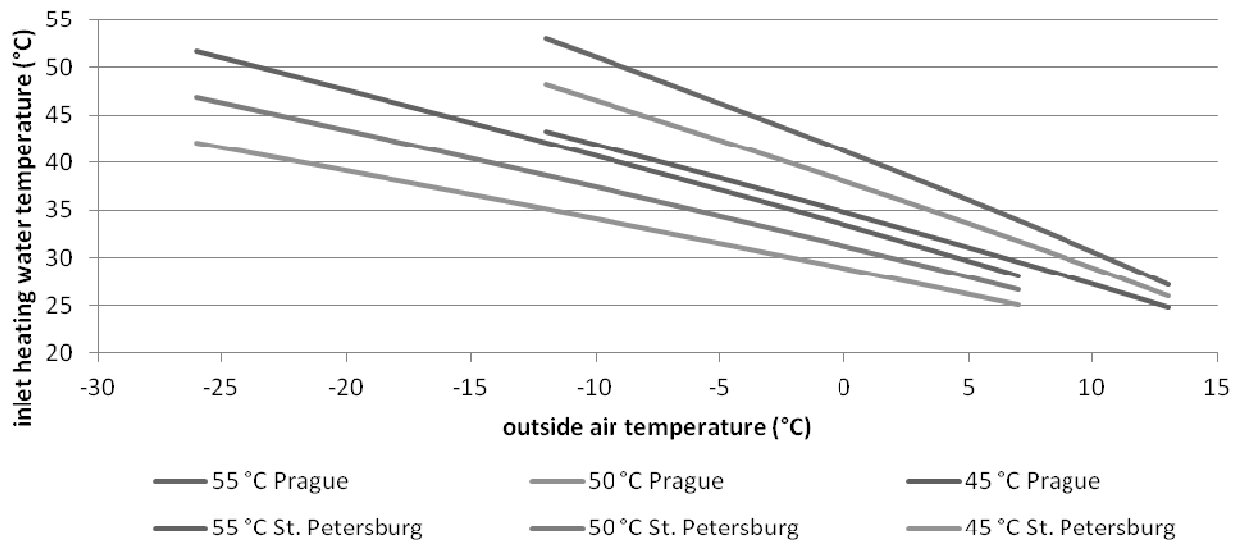
Fig.4. Inlet heating water temperature change according to outside air temperature

There is also a passive cooling module [16]. The main reason for the utilization of passive cooling in the system is to ensure proper regeneration of boreholes. The passive cooling system must be used during summer to cool the indoor air in offices or shops. In summer, the ground is significantly colder at higher depths than the ambient outside air temperature. The heat exchanger installed in the brine circuit transfers the refrigerated capacity to the cooling circuit. The heat pump compressor is not active.

The hot domestic water should be preheated by heat pumps at the temperature of 45 °C and delivered into hot domestic water storage tanks, placed at the technical room of each apartment building. The water should be heated up by a bivalent source of energy at the temperature of 60 °C.

The temperature of heating water will be controlled according to the outside air temperature. The change of the heating water temperature is presented in Fig. 4. The heating season, as it is seen in the picture, in Prague ends at the outside air temperature of 13 °C and in St. Petersburg at 8 °C.

The financial comparison has a goal to show the replacement of the district heating energy source in a 100 % range for the ground source heat pump is profitable in the conditions of Prague and St. Petersburg. Two options are compared. The first one is an original district heating system (100 %) with the traditional source of energy. The second one is a new project with a ground source heat pump (70 %) combined with

the bivalent source of energy, heat from the district heating system (30 %). All comparisons are made for options A, B, C, D described above.

The prices are all in Euro. Moreover, all used prices of equipment, materials and salaries are related to the specific conditions of each city.

Costs of the boreholes earthwork, piping and brine coolant are considered in investment costs. In options A and C, where are new and thermally insulated buildings, three cascade heat pumps are included in investment costs. In options B and D, where are old buildings without thermal insulation, four cascade heat pumps are included. The cascade control and additional equipment are taken in too. The heat pumps and the related equipment are located at the small utility building with a room for the service man. He has a duty to care about the equipment, control system etc. and he has an eight-hour working day. The investment costs include costs for piping, fittings, circulation pumps, related wiring, cost associated with the project and building permit. Costs of the connection of the station is included too, in a new building (option A, C) it has to be built and in old buildings (option B, D) the station will be reconstructed. There is a 5 % reserve of total investment costs.

The price of heat from the district heating system and price of electricity in original and new systems are calculated in the same way. The price of heat in options A and B (Prague) is from producer «Pražskб teplбrenskб», 2014 [17].

The calculated price of heat is 76.6 Euros.MWh^{-1}, the price of electricity is 75 Euro.MWh^{-1}. The price of heat in options C and B (St. Petersburg) is from the data of tariffs in the Kirovsky district in St. Petersburg, 2015. The calculated price of heat is 23.26 Euros.MWh^{-1}, the price of electricity is 36.67 Euros.MWh^{-1}.

The total unit calculated investment costs per MWh of the total energy for the heating and hot domestic water preparation demand per year is 335 Euros.MWh^{-1} for option A, 318 Euros.MWh^{-1} for option B, 285 Euros.MWh^{-1} for option C and 273 Euros.MWh^{-1} for option D.

Obviously, a heat pump needs electricity for its drive and its amount is calculated by a bin method [18]. The hourly based data of ground temperatures in a similar sample ground borehole for the heat pump is available and used, (Fig. 2).

The annual saving of operation costs for heating and hot domestic water preparation thanks to a system with a heat pump is calculated as a difference between the price of heat from the current district heating system and the price of heat after the heat pump implementation for all options. The results of the Net Present Value and the Internal Rate of Return are in Tab. 6. The lifetime of heat pumps is calculated as 25 years and the expected return ratio amounts to 3 %. The costs of modernization of all the equipment are calculated for 10 years after the installation [19].

T a b l e 6

Economic results of the project

CALCULATED OPTION	−	A	B	C	D
SIMPLE PAYBACK PERIOD	Year	10.2	11.2	47.6	64.1
NET PRESENT VALUE	Euro	607 762	528 292	−704 522	−1 107 342
INTERNAL RATE OF RETURN	%	7.81	6.60	−8.01	−11.46

Fig.5. Prices for energy consumption (options A, C) for different tariffs of heat and electric energy

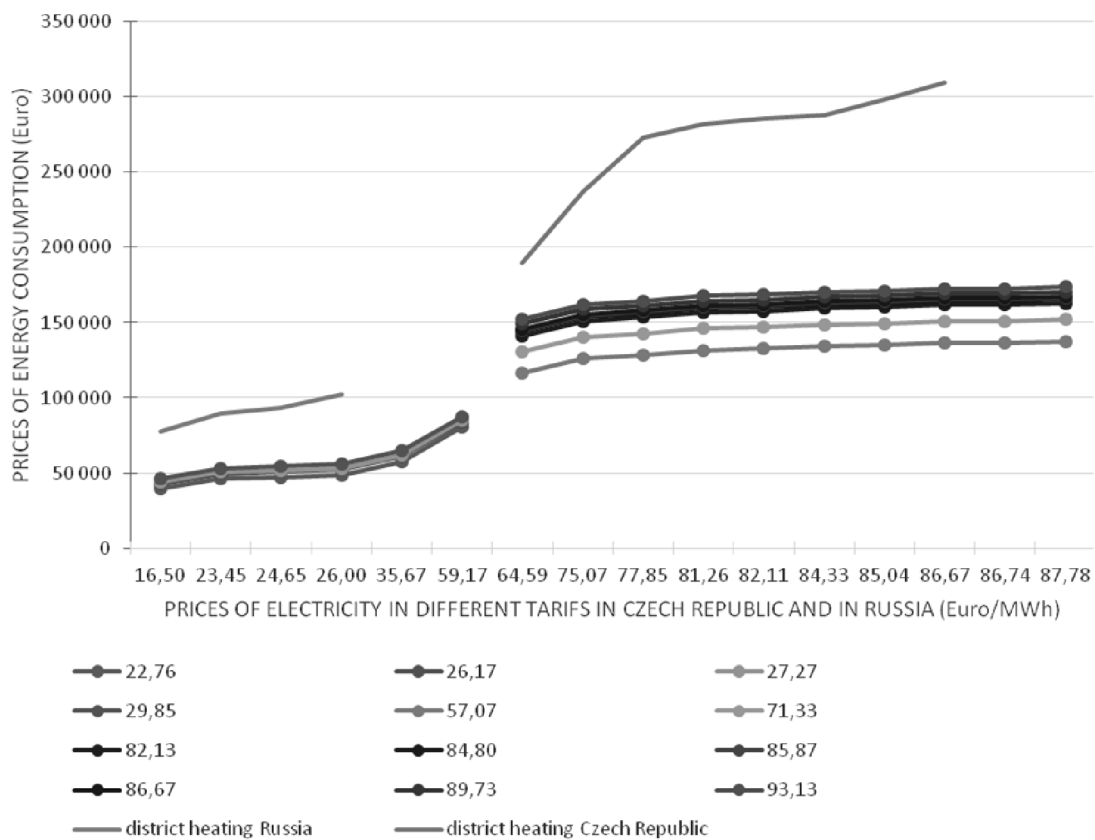The economic factors in Tab. 6 show the basic results of installing a heat pump in new or existing buildings in Prague or in St. Petersburg. The installation would be beneficial in Prague in the case of new, thermally insulated buildings and in the case of existing buildings without modernization. The results for St. Petersburg are not favourable. This is due to much lower prices of energies. In St. Petersburg the electric energy is 2 times cheaper and heat energy is 3.3 times cheaper than in Prague.

In the previous evaluation, the prices of energy were used for Prague and St. Petersburg. In the following graph, Fig. 5, prices of the electric energy and heat energy are considered from the district heating systems in RF and CR. Several tariffs are used. On the horizontal axis of the graph, there are prices for electricity in $Euros.MWh^{-1}$. In the legend under the graph, there are prices of heat energy from the district heating system in $Euros.MWh^{-1}$. The lines with centre marks express prices of the energy consumption for heating and hot domestic water preparation covered mainly by the heat pump (70 %). The smooth lines express prices of energy consumption covered by the district heating system (100 %).

The graph shows that heating and hot domestic water preparation covered only by the district heating system are more expensive in both CR and RF than the utilization of the system with a heat pump. However, the difference between these two systems is slight in Russia. That is why the project with the combination of a heat pump with the district heating system is not profitable.

To crown it all, there has been made the evaluation for the housing estate with 500 flats in Prague and St. Petersburg for new highly thermal insulated buildings and old traditional building. The four options are calculated. Therefore, a complex comparison of both countries and the evaluation with different tariffs of electric and heat energy have been made too.

The financial comparison shows that the profitability of the evaluated system is different in each country. According to the resulting economic criteria, the profitability of the systems is influenced mainly by prices of heat and electric energy. Investment costs of the heating system with a ground source heat pump do not differ much. According to very low prices of energies in RF, compared with CR, the system with a ground source heat pump is not profitable in Russia.

On the other hand, considering not only economic aspects, the alternative energy sources have different advantages. By reducing the energy dependence on one source of primary energy, it is possible to use the cheaper alternative to the energy source while energy prices are changing. In addition, the impact on the environment is reduced by using renewable energy.

The main result of the subsequent disclosure of the subject is the development of innovative technological solutions for the use of heat pumps in the social sphere in order to improve their economic and thermodynamic appeal.

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COMMUNICATION CENTERS
AS AN ELEMENT OF THE INSTITUTIONAL ENVIRONMENT
OF INNOVATIVE ECONOMY

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КОММУНИКАЦИОННЫЕ ЦЕНТРЫ
КАК ЭЛЕМЕНТ ИНСТИТУЦИОНАЛЬНОЙ СРЕДЫ
ИННОВАЦИОННОЙ ЭКОНОМИКИ

The article discusses the relationship of information and communication factors and the level of innovation of a socio-economic system, the importance of informal communication and tacit knowledge within the modern concepts of knowledge economy and communicative economy. The aim of this work is to propose a concept of communication centers, show their place and role in the innovation infrastructure, to identify their basic characteristics and to develop an approach to understanding those of their functions for which the implementation infrastructure could be effectively created in addition to the existing elements of the national and regional innovation systems. The concept that we have adopted as a basis for the study is that the key function of a communication center in the socio-economic system with a given level of development is the organizing the interaction with representatives of socio-economic systems whose levels of development are the same or higher in order to obtain from them (through exchange, purchase, etc.) advanced technology, skills and other kinds of valuable information and knowledge. The main conclusions are as follows. The quality of knowledge at the micro-level, i. e. the long-term human capital of the region determines the actual availability and quality of the communication center in the existing innovation infrastructure of the region. The conducted review of the functions and features of the institutions of regional innovative infrastructure, including the technology platforms and the innovative regional clusters, as well as communications platforms in individual companies, and also the functions of the so-called innovative lift development institutes made it possible to establish that the communication center should have the following main characteristics: it should be intensely involved in the diffusion of innovations; it should integrate the directly interacting units that should be grouped geographically for informal transmission of tacit knowledge; it should have significant executive and administrative authority. A further substantiation of investments into creating the appropriate communication centers and an analysis of their effectiveness seems necessary.

INNOVATIVE INFRASTRUCTURE; REGIONAL INNOVATION SYSTEM; LEVEL OF INNOVATION; KNOWLEDGE ECONOMY; COMMUNICATIONS CENTER; HUMAN CAPITAL OF THE REGION.

Рассматривается связь информационно-коммуникационных факторов и уровня инновационности социально-экономической системы, значение неформальных коммуникаций и неявных знаний в рамках современных концепций «экономики знаний» и коммуникативной экономики. Цели исследования — предложить понятие «коммуникационные центры», показать место и роль коммуникационных центров в инновационной инфраструктуре, определить основные критериеобразующие характеристики коммуникационных центров, разработать подход к пониманию тех функций коммуникационных центров, инфраструктуру реализации которых целесообразно создавать дополнительно к имеющимся в национальных и региональных инновационных системах элементам. За основу исследования принято положение, что ключевой функцией коммуникационного центра в социально-экономической системе с данным уровнем развития является организация взаимодействия с представителями социально-экономических систем с аналогичным или более высоким уровнем развития с целью получения от них (путем обмена, покупки и др.) передовых технологий, навыков работы и иных видов ценной информации и знаний. Качество знаний на микроуровне, или «человеческий капитал региона», в долгосрочном периоде определяет фактическое наличие и качество работы коммуникационного центра в существующей инновационной инфраструктуре региона. Рассмотрение функций и особенностей институтов инновационной инфраструктуры, включая технологические платформы и инновационные территориальные кластеры, площадок и сред коммуникаций в отдельных компаниях, а также функции «институтов раз-

вития инновационного лифта» позволяет установить, что коммуникационный центр интенсивно участвует в процессе «диффузии инноваций», объединяет непосредственно взаимодействующие подразделения, которые целесообразно группировать территориально для неформальной передачи «неявных знаний», обладает значительными организационными и управленческими полномочиями. В дальнейшем потребуется обоснование целесообразности вложений в создание соответствующих коммуникационных центров и анализ эффективности их деятельности

ИННОВАЦИОННАЯ ИНФРАСТРУКТУРА; РЕГИОНАЛЬНАЯ ИННОВАЦИОННАЯ СИСТЕМА; УРОВЕНЬ ИННОВАЦИОННОСТИ; ЭКОНОМИКА ЗНАНИЙ; КОММУНИКАЦИОННЫЙ ЦЕНТР; ЧЕЛОВЕЧЕСКИЙ КАПИТАЛ РЕГИОНА.

Introduction. Is it appropriate to complement the existing institutions of the Russian innovation economy with new elements aimed at maintaining and strengthening the communication function? What is the interrelation of innovation, communications, and their effect on the development of major socio-economic systems in modern conditions? The answers to these questions are highly relevant as it is currently a priority to preserve the market and democratic development institutions under significant external pressure on the socio-economic system of the Russian Federation.

The role of communication in a socio-economic system is discussed today mainly in the works of sociologists like Daniel Bell, T. Van Dyck, Manuel Castells, N. Luhmann, M. McLuhan, T. Parsons, J.P. Habermas, D.P. Havra, D.V. Panarin, V.I. Inozemtsev, F.I. Sharkov, and others.

The factor of communication has arisen as a major innovation-related economic category in the post-war period (i. e. the second half of the 20th century) and has kept its importance until today. Innovation research includes studies by such world-renowned scientists as P. Drucker, P. Kotler, Michael Porter, F. Hayek, I. Shumpetter, as well as works of Russian researchers, such as O.G. Golichenko, L.M. Hochberg, S.V. Kuznetsov, G.B. Kleiner, V.V. Okrepilov, and others.

The scientific literature on the subject analyzes the mechanisms of interaction between the subjects of the Russian national innovation system, as well as the mechanisms of innovative systems formation based on knowledge economy, some aspects of the effectiveness of an innovation infrastructure in a region, the nature and approach to economic analysis of complex innovation activities, and reviews the components of the regional innovation potential. A number of studies also examined the connection of integration of innovative processes at enterprise level and their relationship with macro-regulation at national level [1—4], and the concept of territories of priority development [5].

The role of information and communication in the innovation process is quite widely studied in literature. In particular, the works of V.A. Plotnikov and S.P. Koida [6] study the economic mechanisms of the information society and the role of the information infrastructure in providing innovative development. The article by I.G. Ershova and Y.V. Vertakova [7] focuses on analyzing the indicators for describing the development of knowledge economy in the region. The dependence of communications and the level of development of innovative economy is also considered by the author in the article 'Determining the level of development of the innovation environment in the communications economy' [8].

We should also note that there is a significant amount of useful information related to the development of the innovation potential of the regions of the Russian Federation on the official website of the National Center for Monitoring the Innovation Infrastructure of Scientific and Technical Activity of Regional Innovation Systems [9], and in the materials of a number of conferences [e. g., 10].

These works, as well as some others, study the effect of information and communication technologies (ICT) on modern business practices, the promotion innovative changes, and the impact of several aspects of information and communication factors on the innovation level of a social and economic system. The scientific literature also examines the role of technology transfer centers as an integral part of regional innovation systems, and the processes of transfer of knowledge and technologies in integration-type businesses.

Formulation of the problem. The object of study in this paper is the institutional environment of innovative economy associated with the concept of innovation systems at national and regional levels. The aim of this work is to develop an understanding of the specific elements of the innovation infrastructure which can be defined as a communication center, and to study the possible functions and features of communication

centers in national and regional innovation systems (NIS, RIS), i. e. to describe their key characteristics and to show the place and role of communication centers in the innovation infrastructure. A task connected to the purpose of the study is to identify the currently existing elements of innovation infrastructure at the level of national and regional innovation systems, which can be attributed to communications centers; we are also going to develop an approach to understanding the functions of communication centers for which it would make sense to create the implementation infrastructure in addition to the existing elements.

The methodology of the study. The premise of the study is that it is possible to isolate a number of functions of the national and regional innovation systems and to form on the basis of that a concept of a new element of an institutional environment of innovative economy, which is the communications center. Since the national-level stability is currently achieved largely through the inclusion of the economic system of the country in the international division of labor, it will be important to underline an international focus of the element in question.

The research methods of this article are based on the system analysis of the existing elements of the innovation infrastructure. We offer a unique viewpoint on the composition of the core and additional advanced functions of communication centers, and on the key characteristics and the set of components included in the concept.

Communication in the innovation economy. A communication (or communicative) economy may be defined as a type of modern social and economic system in which the knowledge required for implementing the innovation process is created, disseminated and used through information communications. The main function of the communications center in the socio-economic system with a given level of development is organizing the interaction of representatives of socio-economic systems with the same or higher level of development in order to obtain from them (through exchange, purchase, etc.) advanced technology, skills and other kinds of valuable information and knowledge.

A system of knowledge transmission and dissemination for further use that is mentioned

in virtually all definitions of knowledge economy or communicative economy [11, 12, 13, 14, 15] is a key feature and a central element of a modern innovation system. The dissemination of knowledge implies the pre-existing intensive communications which allow the conversion (or 'materialization') of knowledge into innovation and indicate a high level of innovation of a given socio-economic system, and create a platform for the acceleration of economic growth.

The currently developing system of knowledge dissemination (the innovative environment) becomes an information and communication factor of economic growth. Knowledge as the intangible capital is disseminated through formal and informal networks. The divisions of large organizations in various countries and regions between which there is a movement of employees are an example of formal networks. (E.g. the units of national (in large countries) or transnational companies, the network of diplomatic missions of a state, federations, associations and the events they hold, such as competitions, conferences, forums, etc.)[1].

Informal knowledge networks are formed through informal communication in the local community, and through these communities that may consist of socially active population groups with varying skill sets and lifestyles adopting professional slang and 'habits', as well as implicit and explicit life values, including the ratio of individual and group interests, concepts of prestigious quality products and places of residence and work, and other values.

The mobile part of the top qualified professionals move into different industries and different countries and regions, where additional incentives have been created or the innovation environment (according to M. Castells) has spontaneously evolved, and thus form *a mobility reserve* in the knowledge economy and promote informal knowledge transfer, using as a vehicle

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[1] It may be assumed that a number of measures of the federal target program «Scientific and scientific-pedagogical personnel of innovative Russia» for 2009–2013 and for 2014-2020, approved by the Decree of the Government of the Russian Federation of 28 July 2008, № 568 and Decree of the Government of the Russian Federation of May 21, 2013 № 424, respectively, are aimed at establishing formal knowledge networks in Russia in the field of research and innovation.

the formal knowledge networks. This circulation and communication of highly skilled workers among the various branches and regions can be linked to the information and communication factor of economic growth.

We should note that implicit knowledge disseminated through informal networks includes the culture of thinking, the decision-making algorithms, the personal acquaintances, the value priorities, the intuitive assessment of situations and other elements that are difficult to formalize. This knowledge is acquired by a person through an extended stay in specific innovation environments such education in certain universities, training programs, or certain work environments. B. Lundvall highlighted four ways of learning tacit knowledge «in the process of work, in the process of use, in the process of searching, and in the process of learning by interaction» [16].

It is obvious that values, beliefs, and personal acquaintances distributed through formal and informal networks in the knowledge economy have a significant impact on the decisions made by an individual or a group. In the knowledge economy, trust between partners takes the form of economic interest and is expressed in the high evaluation of the assets and the innovative capacity of the economic actors that appear to be the most promising for cooperation and capital investment (for example, a sharp rise of Apple capital value in 2014).

Reduced confidence in partners, understood as a factor of knowledge distributed through informal networks, may lead to a decrease in the worth of the international liquid assets and the re-assessment of the innovative capacity of a company. An example of this is a sharp decrease in the capitalization of the Russian stock market that has happened in 2008 and in 2014. While the effectiveness, and, consequently, the fair market value of the largest Russian companies in the RTS and the MICEX indices could not have changed so drastically due to political reasons, the information from the informal knowledge networks has had a significant impact on investors from countries that have not officially recognized the independence of South Ossetia and the new status of Crimea.

Thus, assessments made in the informal environment of the global innovation economy can significantly influence decisions about investing into various economic assets.

Communication centers in the innovation environment. The scientific literature has developed an understanding that the innovation environment is represented by a set of institutions that reflect the stages and phases of the innovation process which is defined as the innovation infrastructure, the institutional environment of innovative economy and the national innovation system (NIS) [17]. The NIS encompasses a complex of institutions that provide innovative processes and possess certain production traditions and political and cultural peculiarities. It is a system of interconnected institutions of various specialties working in the country and employed in innovation activity and the implementation of innovations (large, medium and small innovative companies, government agencies, universities, technology parks and incubators, etc.) that combine various types of resources including physical, financial, intellectual, scientific, technical and other necessary for innovative activity [18].

The basic parts of the innovation infrastructure are the following: technological (industrial and technical) infrastructure, the financial infrastructure, the training infrastructure, marketing, the information and consulting infrastructures.

The government program of the Russian Federation 'Economic development and innovative economy' (2013) states that the effective functioning of the 'innovation lift', i. e. a network of state-created development institutions that support innovative projects at all stages of development (sub-program 5 'Promoting Innovation', the main event 5.6 'Creation and development of institutions and infrastructures, providing launch and operation of an innovation lift') [19] is a tool ensuring the coordination of economic entities with the goal of supporting innovation. A mechanism for sharing information about promising innovation projects should be created as part of the innovative lift, and a transfer of such projects from one development institution to another should be established. The functions of information exchange and transmission imply that it is the development of the institutions mentioned in the government program that are most closely associated with the theoretical principles of the communication centers of innovation infrastructure that are discussed in this paper.

At the moment, however, the mentioned institutions are not a fully developed element of the mechanism of innovation management in the

Russian Federation, and their status is not entirely certain. In view of this, it is our belief that developing the concept of communication centers of innovation infrastructure would allow to enrich the concept of the 'institutions of the innovation lift development».

While discussing the concept of the institutes of development, the Head of the International Laboratory for Economics of Innovation of HSE (Higher Scholl of Economics in Moscow) L.M. Hochberg emphasizes that a function of the institutions of the innovation environment and research funds to support innovative projects and initiatives communication platform is to serve as communication platforms [20].

The vertical classification of innovation infrastructure institutions designed by L.M. Hochberg highlights the important role of the development institutions with the function of communication platforms which is thus one of the central organizational functions necessary to determine the tasks to be solved within the framework of the research and production levels of the innovation infrastructure institutions, including the technology platforms and innovative territorial clusters.

It is known, in particular, that the creation of technological platforms in Russia in 2010 repeated the European experience [21]. At a time when the behavior of venture capital and small business in Europe was not similar to the venture boom in the US, there was an effort to involve industrial companies into research-based synergies with research and government agencies at the pre-commercial stages of innovation projects. Communication Centers within technology platforms can be an important tool connecting the requests of industrial companies with the relatively independent research carried out under the programs of state support of science (Russian business structures are coordinating only two out of 34 platforms; these are a Laser Association nonprofit organization and SUEK, LLC).

Innovative regional clusters are widely studied and discussed in scientific literature. If we assume that cities evolved as craft and trade clusters, the city of Заталнцуьк, which was founded in the 8th millennium BC and specialized in ceramics, non-ferrous metallurgy and production of hand tools, can be considered the first example of such cluster. A cluster of textile industry formed in Manchester in the 18th and the 19th centuries, while a cluster of steel and chemical industries formed in the Ruhr Basin; the 1960s saw the emergence of Silicon Valley. Until recently, the clusters have formed spontaneously, and their targeted development started in the second half of the 20th century. One of the examples is the Research Triangle Park, a technology center in North Carolina which had previously been considered, being a tobacco state, so to speak, one of the poorest regions in the United States. A biotechnology cluster Medicon Valley has formed on the border of Denmark and Sweden. Numerous other examples could be cited.

In contrast to the cluster system, the territorial industrial complexes built in the USSR were, essentially, state-planned production chains that did not allow for domestic competition, and were thus less flexible and adaptable despite better outputs due to their scale.

Modern communication centers operating on the level of innovative regional clusters are meant to be a field of interaction of equal players, i. e. the ordering industrial and commercial companies, research companies and centers, government agencies designed to allocate funding and monitor the results of development of innovation infrastructure in the regions.

The role of communication centers in the institutional environment of innovative economy can be presented as follows (see. Figure).

The upper part of the figure represents the key elements of the regional innovation system, while the lower part represents the national innovation system.

The level of development of the institutions of the innovation infrastructure in the regions (regional innovation systems) shows significant variations [22—24]. The regions typically have the largest share in the structure of national innovation systems, since the regional innovative environment is focused on market diversification and replicating the innovations developed and tested in the leading regions (donor structure), or in the regions which possess versatile innovation environments. These innovative recipient regions shall enter the innovation process at the stage when the pre-prepared innovation projects are continued or completed, carrying on the process of commercialization of innovations [25].

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┌─────────────────────────────────────────────────────────────────────────┐
│                        Human Capital of the region                        │
├──────────────────────────┬─────────────────────────┬─────────────────────┤
│  Local production clusters │  Local innovation clusters │ Technology transfer centers │
├──────────────────────────┴─────────────────────────┴─────────────────────┤
│       The territories of priority development (TOR), special economic zones (SEZ)       │
└─────────────────────────────────────────────────────────────────────────┘
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┌──────────────────────┐       ┌──────────────────┐       ┌──────────────────────┐
│ Foreign partners, programs │ ⟷ │ Communication Center │ ⟷ │ Development institutions │
│     of cooperation     │       │                    │       │ of «innovation elevator» (lift) − │
│  with foreign partners  │       │                    │       │   at federal and regional levels   │
└──────────────────────┘       └──────────────────┘       └──────────────────────┘
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┌─────────────────────────────────────────────────────────────────────────┐
│  The laws of the Russian Federation, regulations of the Government and other federal laws │
│                establishing the procedures for innovation                 │
├──────────────────┬────────────────────────────────────────────────────────┤
│   Technological   │ Systems of technological forecasting and monitoring of scientific − │
│     platforms     │  technological progress by economic sectors / industries (STP)   │
└──────────────────┴────────────────────────────────────────────────────────┘
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The role of communication centers in the institutional environment of innovative economy in Russia

The defining characteristic of knowledge in terms of competitiveness is its quality. The quality of knowledge at the micro-level is a set of professional skills of employees. The differentiation of innovative potential of countries and regions is affected by the level of professional competence, education and qualifications of their working population, which is to say the human capital and the service capital [26]. The human capital of the region determines both its level of development as an innovation environment and that of the institutions of knowledge economy in a given country or region.

The process of innovation diffusion diffusion is traditionally portrayed as a step-by-step penetration of innovations from the donor regions into the recipient regions. The territory of the regions serving as innovation donors contains, as a rule, a developed innovation infrastructure (like the largest innovation centers such as Silicon Valley in the United States or the Maastricht Triangle in Europe that have served as a basis for the Skolkovo and Tomsk innovation zones), as well as branches of large foreign companies, which helps to create innovations or borrow them from other countries.

In the face of pressure from the outside and geopolitical competition during the Soviet era, Russia had its own experience of creating scientific and innovative centers such as Dubna or Troitsk near Moscow, and other closed cities. However, the military technologies that were the product of the donor regions in the Soviet period, while advanced for their time, had no commercial prospects for the consumer market.

Innovative communication centers today must indeed support the marketing function of the commercialization of innovations in the consumer market or B2B market. At the moment, there is yet no concept of communication centers of the innovation infrastructure in scientific literature. However, the innovation infrastructure institutions responsible for the distribution and the penetration of innovations (the so-called diffusion of innovations) may be used as communication centers. For the purposes of this discussion, communication centers can be divided into three markets: the defense customers market (characterized by high secrecy), the industrial market with large customers, and the consumer market.

Since part of the innovation institutes are directly or indirectly responsible for the communication functions, the first step in determining the effectiveness of introducing the additional elements related to the diffusion of innovation to the innovation infrastructure in the region is to locate the organizations whose activities can be attributed to the communications center, and their markets. In order to classify parts of the existing institutions of the NIS and RIS infrastructure as communication centers, it makes sense to consider their characteristics, and functions which would be responsible for the processes of sharing and dissemination of knowledge.

We should note that there are special areas and environments which are designed to increase

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the interaction and communication intensity to achieve the best results, and, ultimately, allow individual companies to implement their innovative potential within the framework of strategic development programs [27]. Given the important role of geographical proximity for organizing informal communication and transfer of tacit knowledge in the process of dissemination of innovations, such sites can be functionally defined as communication centers at the level of individual companies.

Based on the company size, we may assume that communication centers should be developed:

A) At company level. Among contemporary examples of creating a platform for the communication center of the largest company is The project of association of research assets of state corporation «Uralvagonzavod» in a new dedicated building in St. Petersburg [28].

B) At the level of associations of commercial and non-profit organizations at the regional level. It is our opinion that university scientific and innovation centers present a good format for communication centers of this scale (for example, the Peter the Great St. Petersburg Polytechnic University Technopark, the ITMO University Innovation Park, or the Center for Collective Use of Equipment of the National Mineral Resources University in St. Petersburg, Russia, as well as institutions associated with further development of the concept of innovative regional clusters).

C) At the level of associations of commercial and non-profit organizations at the federal or inter-regional level with the inclusion of public-private partnership elements. Examples of this include Skolkovo in Moscow, the innovation zones in Tomsk, Innopolis in a suburb of Kazan, the Arctic cluster project in the Northwestern region with the center in St. Petersburg [29], as well as institutions associated with further development of the concept of innovative technology platforms.

In all these cases, an important feature of the communication center is the close proximity of the units gathered together, which is an important condition for the direct interaction of staff and for informal networks to function on this basis, contributing to the transfer of tacit knowledge the importance of which has been mentioned above.

If we follow this approach, it would be justified to conclude that the communications center cannot be a division simply providing information (i. e. is similar to a data or an expert consulting center); the center must have a certain set of management powers allowing to assign tasks to other production units.

Thus, the innovation infrastructure communication center should have at least the following set of characteristics: it should be heavily involved in the process of innovation diffusion; it should integrate the directly interacting units that should be grouped geographically for the informal transfer of tacit knowledge; it should posses organizational and managerial authority.

Moreover, the following additional characteristics of a communication center may be mentioned:

– its international nature due to orientation towards collaboration with foreign partners;

– its focus on the current mechanisms and legal forms of the public-private partnership (PPP), which meets the requirements of efficient business in modern conditions;

– a substantial PR-component able to engage the so-called creative class of the country and domestic and foreign business partners in the work of the communications center;

– providing humanitarian and business cooperation with the Russian state and military structures, including the structures of the Rear of the Armed Forces of the Russian Federation.

The last characteristic is of fundamental importance as it expresses a new approach to the cooperation of military and civil structures in Russia and the information openness of the state.

These promising characteristics of communication centers are a subject for further analysis and research.

In this study, the following main results have been achieved:

1. Communication centers were tentatively defined as institutions of the innovation infrastructure responsible for the distribution and the penetration of innovations (innovation diffusion), the effectiveness of which is determined in the long-term period by the human capital of the region. This definition specifies the basic direction of future research, including the principle of evaluating the effectiveness of the communication center.

2. To find the characteristics that are recommended for establishing a regional innovation infrastructure communication center we have suggested an approach connected with monitoring the existing institutions of the innovation infrastructure, platforms and media communications

in individual companies, as well as the functions and features of development institutions of the innovation lift in the region. Such an approach allows to fully use the opportunities and improves the targeting of additional functions of the communication center in case it is established.

3. The basic key characteristics of a communication center are found; these are the intensive participation in the process of innovation diffusion; the geographical closeness of an association of directly interacting units in order to transmit informal tacit knowledge; the significant organizational and managerial powers.

The author sees the following direction for further research: the description of those functions and features that the communication centers as a specific element of the innovation infrastructure can contribute to national and regional innovation systems (NIS, RIS), technology platforms and regional innovation clusters including technology transfer centers and other existing elements of innovation infrastructure and integration forms of business. In the future we also need to study the advisability of investing into establishing the appropriate communication centers and to analyze their effectiveness.

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MANAGEMENT OF INDUSTRIAL STABILITY AND DEVELOPMENT IN THE CONTEXT OF SYNERGETIC PARADIGM

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УПРАВЛЕНИЕ УСТОЙЧИВОСТЬЮ И РАЗВИТИЕМ ИНДУСТРИИ В КОНТЕКСТЕ СИНЕРГЕТИЧЕСКОЙ ПАРАДИГМЫ

Solution to the problem of maintaining the efficiency and stability of the developing industry is subject to quick and sudden changes in the globalizing business environment has recently been of priority in the economic research. In the dynamic background of the institutional and innovative transformation in Russia activities of industrial enterprises are subject to risks of resource deterioration, competitive advantage loss and sliding towards bankruptcy. On this account it is an important challenge to develop and improve control technologies for stability of enterprises. For this purpose, we suggest theoretical, methodological and applied support of the design technology, including the involvement of both familiar tools of systems analysis, management, cybernetics, etc. and of innovative knowledge of nonlinear dynamics and self-organization theory which form the foundation for the interdisciplinary synergetic paradigm. Within the framework of its ideas, a logical explanation is given to the evolution of industrial enterprises from unstable equilibrium to stable non-equilibrium, as well as to qualitative modifications in their activities, in particular, those connected with the transition from a stable and less effective state to a more effective one. Along with this, from the perspective of the entropy approach and information theory, it becomes possible to give reasons for the nonlinear (exponential) dependence of the industrial enterprise performance on the amount of the accumulated information and to substantiate conditions for maintaining the stability of this effect, as well as the multi-factor analysis of dependence of financial and economic indicators of the enterprise performance on the knowledge achieved by the enterprise. In order to apply the concept and technology of managing the industrial enterprise stability, including the use of the heuristic algorithm (based on fuzzy sets), there has been developed and certified the software to monitor their stability which fulfills functions of the operational processing, visualization and understanding of change trends with regard to indicators observed.

KNOWLEDGE; INFORMATION; MONITORING; FUZZY SETS; EQUILIBRIUM; STABILITY; EVOLUTION; ENTROPY; EFFICIENCY.

Приоритетное значение в экономических исследованиях последнего времени приобретает решение проблемы поддержания эффективности и устойчивости развивающейся индустрии, подверженной воздействию быстрых и резких перемен в глобализирующейся деловой среде. На динамичном фоне проводимых в России институциональных и инновационных преобразований деятельность промышленных предприятий испытывает риски деградации ресурсов, потери конкурентоспособности и сползания к банкротству, ввиду чего актуализируется задача разработки и совершенствования технологии управления устойчивостью предприятий. С этой целью предлагается теоретическое, методологическое и прикладное оснащение проектируемой технологии с привлечением как известных инструментов системного анализа, менеджмента, кибернетики и др., так и новейших представлений нелинейной динамики и теории самоорганизации, образующих основания междисциплинарной синергетической парадигмы. В рамках ее воззрений находят логичное объяснение эволюция промышленных предприятий от неустойчивого равновесия к устойчивому неравновесию и качественные перестройки в их деятельности, в частности связанные с переходом от устойчивого менее эффективного состояния к более эффективному. Наряду с этим с позиций энтропийного подхода и теории информации становится возможной аргументация нелинейной (экспоненциальной) зависимости эффекта деятельности промышленного предприятия от количества накопленной информации и обоснование условия поддержания устойчивости этого эффекта, а

также многофакторный анализ зависимости финансово-экономических показателей работы предприятия от достигнутого им уровня знаний. Для прикладного обеспечения концепции и технологии управления устойчивостью промышленных предприятий с применением эвристического алгоритма (на базе нечетких множеств) разработана и апробирована компьютерная программа мониторинга их устойчивости, выполняющая функции оперативной обработки, визуализации и осмысления тенденций изменения наблюдаемых показателей.

ЗНАНИЕ; ИНФОРМАЦИЯ; МОНИТОРИНГ; НЕЧЕТКИЕ МНОЖЕСТВА; РАВНОВЕСИЕ; УСТОЙЧИВОСТЬ; ЭВОЛЮЦИЯ; ЭНТРОПИЯ; ЭФФЕКТИВНОСТЬ.

Introduction. Drastic alterations in the Russian economy against the acceleration of the innovation flow place priority in the research on the theoretical, methodological and practical issues of forming the modern mechanism of increasing competitive capacity of industrial enterprises. High dynamism of transient processes and mastering tools of innovative modernization in the globalizing world focus the attention of experts on the concept and means of managing stability and development of production systems within the framework of natural-scientific and economic ideas.

It is known that today in terms of manufacturing innovative products Russian enterprises prove to lag behind not only the leading countries but also behind a number of fast developing ones, and regions are unable to compete in the world market in terms of innovative activity and advancement of large innovative projects. So far, there have been only few industrial enterprises in Russia which carried out innovations in 2010−2014: in terms of technological innovations it accounted for from 9.3 % to 9.9 %. Moreover, the volume of innovative goods, processing works and services in the total amount of shipped goods and executed works in those years was meagre and accounted for between 4.5 % and 13.7 % [1]. As a result, Russian enterprises are not only outperformed by their foreign partners in the innovative development, but they are also significantly different from each other both in terms of the financial-economic and scientific-innovative level, which generates difficulties in the choice of directions and projects of enterprises' innovative modernization.

The importance of understanding these problems becomes even higher if taking into account the fact that issues of planning and analyzing the development of production systems with the nonlinear nature of their behavior and synergetic ideas have not been worked out deeply, theoretically and methodologically yet. All the more important are the results obtained by the colleagues both in the conceptual and applied aspects to manage stability and development of industrial enterprises under conditions of modernization of transnational and national industrial complexes and establishment of knowledge economy.

1. Objectives and methodology of the research

The objective of this article is to delineate the contours of the theoretical, methodological and applied approaches to the analysis of stability and development of industrial enterprises from the perspective of transformational processes and scientific paradigms.

The concepts of the theory of systems, system analysis, cybernetics and synergetics have become the basis for the research methodology. Theoretical fundamentals of these sciences allow exposing and realizing behavior and development of complex dynamical systems, their evolution and restructuring in the conditions of the changeable economic environment. In the view of classic and modern concepts about the systems, the author generalized the results obtained earlier in regard to the systems complexity, their chaotic and ordered behavior.

2. Evolution and nonlinear processes in the operation of production systems

A rapid flow of institutional and innovative changes in the business environment force Russian enterprises to test external and internal threats, and, therefore, they undergo a continuous change of their state and behavior. In the epoch of globalizing world economic relations and aggravating the competitive struggle the ability of enterprises to divert the risk of irreversible degradation and maintain their stability is of crucial importance. In this connection the information aspect assumes an active and dominant role, filling up the production system environment with knowledge − implementation of innovations into technologies and products.

With the intensification of the environment information saturation the impressive growth of generated and consumed knowledge implies the

accelerated innovative development of enterprises and shapes the face of the country's future economy. However, taking into account the unusual progress in the area of human labor informatization and computerization, we may consider that the natural-scientific and economic methods have not been implemented to their full extent with regard to planning and analyzing the production systems behavior.

It is clear that the primary attention is paid to the analysis of conditions of equilibrium acquisition and loss and stability of industrial enterprises in the transformational environment of the Russian economy. The conducted research has shown the following: the forced and radical reformation of the country's national economy caused destabilizing processes which prevent industrial enterprises from achieving stable equilibrium. The system and cybernetic principles confirm that such a macro-economic scenario under the conditions of Russia could result only into the disturbance of resource flows among enterprises and weakening their stability in a strongly disturbed environment during the transition period. In addition, applying the Lyapunov [2] criterion allows us to prove that, with proper control of enterprises' performance and resource opportunities, their adaptation mechanism can provide the asymptotic stability for one of the key indicators of their financial stability − autonomy indicator. In other words, whatever the share of proprietary funds in enterprise's liabilities, they will squeeze the borrowed funds over time. A similar feature is also inherent in the indicator of income from selling enterprise's products: regardless of the initial value of the income, its actual value reaches the planned value if there is a required resource potential, as well as the competent management of resource production processes, sales and consumption.

However, problems of the economic stability analysis do not imply only studying the influence of transformational factors. Therefore, there regularities of the production system evolution have been studied, and synergetic interpretation of their modifications and transition from unstable equilibrium to stable non-equilibrium has been formulated. Thus, if the dynamical system features stability, acceptable disturbances do not have the impact which could change the system behavior fundamentally. On the other hand, if the system is unstable, the influence of disturbance becomes significant and even minor fluctuations may cause drastic changes in the dynamical system behavior. In such a nonequilibrium situation, the insignificant external factor effect at the appropriate moment may radically change the nonlinear behavior of the system, located at the bifurcation of possible system motion trajectories. A specific direction of the trajectory will be selected from their bundle based on the nature of the process and effect of random (not necessarily powerful) factors in the system bifurcation point. The identified regularity of transformations and evolution of production systems indicates cause and effect relationships between the historically established factors of labor activity, structure, information and stability of the system's behavior.

3. Synergetic paradigm in the system of natural-scientific and economic ideas on the development of industrial enterprises

In a number of the system research, synergetics is among the integrating fields of the scientific knowledge; it synthesizes ideas of theoretical physics, chemical kinetics, etc. Due to its self-organization, the system has the repression of chaos, it becomes ordered and identifies new properties which are absent in its subsystems. As a result, synergetics has become able not only to embody the cooperation of scientific disciplines but also to express regularities of cooperating parts of the nonlinear system through its ideas.

As we know, the nonlinear system is rich in qualitatively different states, the sequence of which forms the hierarchy of instabilities. Unlike physicochemical systems, the manifestation of regularities of nonlinearity, self-organization and synergetic effects still remains a poorly studied subject, except for a number of informative publications [3−5].

Meanwhile, the complex game of randomness and determinacy, slow and fast processes in nonlinear systems leaves broadens the manifestation of instability that becomes an attribute of such systems. It seems that such processes can also be observed in nonlinear production systems under the influence of the innovation flow, which initiates the decay and oscillation of processes involving stable and unstable states. The effect of innovations can agitate the dimensional flow of a process and generate fluctuations accompanied by irregular resource expenses and loss of stability of the system behavior equilibrium mode. This leads to the formation of states

diverting the trajectory of the production system motion from the equilibrium one and, in addition, having different information contents, this or that level of organization (randomness) and governed by synergetic regularities.

Accordingly, it should be noted that along with the acceleration of the social progress the conditions become mature to modernize production systems and enrich their information potential, which favors the increase of their stability in the face of institutional and innovative disturbances in the economy. By revealing the regularity of unstable behavior in complex systems and its manifestation in modern production systems from the point of synergetics and catastrophe theory, it becomes possible to establish causes and peculiarities of the process of losing stability, as well as to explain soft (initial stage of enterprise crisis) and hard (slow crisis or more unstable performance of enterprise) loss of equilibrium stability depending on enterprises crisis dynamics.

Within the framework of the ideas on nonlinear dynamics and catastrophe theory, we would like to pay attention to the regular change in the development of industrial enterprises when they transmit from one stable state to another, the first of them being characterized by lower, and the second one − by higher efficiency. For this purpose, we use the qualitative findings of the surgery theory which are described by Arnold [6]. It appears that a lowly developed economic system with fewer losses turns into the improved stable state if to compare with a more advanced system, the stability of which runs into additional difficulties to obtain a stable effective state. If it becomes possible to have an intermittent rather than a continuous transition of the system into the improved stable state, when approaching such a state it will evolve (will be attracted) towards this state on its own.

Without covering all applications of scientific disciplines to solve the problem discussed, it is apparent that by invoking the ideas of synergetics, system theory, information theory and catastrophe theory, it is possible to lay preconditions to solve the problem of forming the theoretical, methodological and applied tools for research and providing the stability and development of industrial enterprises [7]. In particular, entropy, nonlinear and synergetic approaches allow explaining the evolution and bifurcation in the

behavior of production systems [8− 10], Bohr's complementarity principle [11] − complementarity of probabilistic and determinate information description, Zadeh's principle of incompatibility [12, 13] − invoking the theory of fuzzy sets to handle heuristic information in search models for management solutions and their intellectualization.

4. Knowledge resource as a precondition for maintaining the stable effect of industrial enterprises

Based on the knowledge of statistical physics [14−16] and the fact that useful information, entered in the production system, reduces randomness and entropy in it but increases the effect of its operation, a mathematical condition for stability of this effect has been obtained. The nonlinear form of statistical relation between the accumulated information resource and the effect of the system performance reveals a notable regularity of resources provision with a stable effect within the range of its small and large values. Along with the relative increase of costs due to the growth of the effect, the consequence of this regularity is a priority to materialize scientific knowledge and to launch high technologies in order to maintain the stability of the growing effect of the production system operation.

In respect of the informational aspect the indicator of the knowledge accumulated by the society and built into the economic system (design of machines, combination of units, etc.), and indicator of the management perfection process in Trapeznikov's concept are generalized by the indicator of the knowledge level and skills used or simply by the level of knowledge [17]. It is an indicator that is determined by the amount and usefulness of the input management information and used knowledge when establishing an enterprise. Formally, the level of knowledge is proportional to the product of indicators of labor performance measured with respect to the net product, and the capital productivity. According to Trapeznikov, both the level of knowledge and labor performance reflect the effect of labor (qualifications, skills, etc.), social-psychological (ambition, persistence, discipline, etc.) and other factors.

The importance of our research with regard to the level of knowledge and its relation with financial and economic indicators of the enterprise performance is as follows. Firstly, there is formalized the dependence of the knowledge

level on indicators of economic efficiency (labor performance and efficiency of circulating assets) of the enterprise activity and on the structure of its balance sheet (financial proportions) in the context of assets, liabilities and between them. Therefore, we can state that the level of knowledge generalizes both economic and financial interactions in the enterprise performance. The latter evaluates the balance sheet structure in both of these perspectives: vertically and horizontally.

Secondly, the level of knowledge is in direct proportion both to the current liquidity ratio that is «positive» to reduce enterprises' bankruptcy probability and the related financial strain ratio that is «negative» in this context, which indicates the nontrivial interaction of factors.

Such inconsistency emphasizes a dual role of the loan capital: it plagues enterprise liabilities with debts, degrading its financial stability and increasing the probability of bankruptcy, but, on the other hand, it enables using raised funds to increase enterprise's economic activity, which is reflected in the growth of its performance efficiency indicators. In such an encouraging case revenues grow from sales of products, enterprise payment opportunities are improved, values of labor performance and circulation assets efficiency increase and, as a result, the level of knowledge becomes higher.

5. Information and efficiency of the developing system of industrial enterprise stability management

It is also relevant to consider an issue on the efficiency of the very developing system of management for industrial enterprise stability. The design and implementation of this system require the involvement of information and computer equipment, algorithm and software program elaboration, which is due to additional costs covered by the stream of steadily maintained income. We consider that the system efficiency depends on its structure and cost, returns and payback, bearing in mind that the enterprise income stability is provided by the whole aggregate of the management system components.

According to Trapeznikov's concept [17], the maximum values of the enterprise economic effect are implemented only in the case of a rapidly growing cost of the system, and within the framework of knowledge of the statistical physics and entropy approach there is a correlation between the initial and accumulated information

and the effect of the enterprise operation. Therefore, the effect in the area of small values requires less increment of management information, unlike the field of large values, and with the approximation of the effect to the marginal level the amount of the required additional management information at the enterprise grows rapidly.

Let us pay attention to the effect level of the enterprise activity that will remain stable despite the effect of emerging fractions. By the nature of the obtained dependence, we may state that, with comparatively small values of the effect, maintaining its stability is less resource-intensive than for the value of the effect close to the maximum limit.

It is relevant to advance a hypothesis that the trends of change in ordering and efficiency of the production system behavior follow definite cyclic regularities which reflect the nature of its innovative development. Modernization of the system may involve not only the renewal of its elements but also the restructuring of the established internal relations and operating procedure, which may involve degradation of the ordering system operation in the first instance. Furthermore, re-equipment of technical software and other tools is well grounded on the investment pool which assumes the investment of financial resources and local reduction of management efficiency indicators. Only in the course of time, in the process of mastering innovations and with the growing input of coordinating information, conditions appear to compensate the lost order and, due to the improved organization of the system behavior, to advance its activity to a higher level.

6. Outlines of the concept and technology for managing the industrial enterprise stability

Within the framework of the objective to design the applied aspect of providing the industrial enterprise stability and development there have been substantiated the concept, functions, structure and tools of the system to manage its stability. Based on the importance of the management system, the enterprise fulfils tasks aimed at providing the adaptive management – planning and assessing its performance, early diagnostics of problematic situations, modeling the process and recovery of enterprises stability, monitoring actual indicators and adjusting target indicators of its performance.

Elaboration and practical implementation of the suggested methodological principles in the

startup software product «Computer support for monitoring the enterprise activity (version 1.0)» (project manager Chuprov, Kanevsky's algorithmic support and software) allow us to research the dynamical properties of an enterprise and obtain a broad set of statistical characteristics, which enables carrying out forecasting, assessment, analysis and interpretation of the stability of enterprise performance indicators and represents a means of acquiring knowledge on its nonlinear operation and adaptation of the enterprise to the stability management system.

Our research proposes a promising approach to increase information capacity and efficiency of management solutions on the basis of using the mechanism of the theory of fuzzy sets which represents a tool for processing poorly formalized heuristic information and intellectualization of management systems. By introducing fuzzy sets in the algorithms of the startup software monitoring product there have been implemented operation of expert information to analyze the enterprises performance and obtained an opinion on their stability in the natural language.

Thus, the concept of modeling the computer technology to monitor the industrial enterprise stability is based on the expanded use of professional knowledge, algorithms for searching and maintaining the stable mode of the enterprise operation under the conditions of high disturbance of the environment and shortage of accessible information about it. The information and intellectual environment of this task provides for the integration of advantages of optimization and flexibility of searching management solutions in the models with fuzzy resource restrictions, adequate to incompleteness of information and diversity of states in production systems. As a result monitoring of industrial enterprise stability becomes an intellectual tool in the struggle for viability of enterprises in the environment of institutional and innovative transformations of the modern economy.

7. Conclusion

The progress of theoretical, methodological and applied tools of scientific cognition and demands for economic practice have given impetus to the research of the nature and conditions for providing the viable activity of industrial enterprises. Globalization and aggravation of competition have become dominants of our time, as well as the growth of the flow of changes and the related trial for the performance of industrial enterprises. A rapid rate of generation and implementation of innovations «exhausts» the enterprise performance and hereby making preconditions for changing the phases of equilibrium and nonequilibrium, stable and unstable functioning of its production systems, the behavior of which is subject to the regularities of nonlinear dynamics and synergetics.

However, cardinal transformation of the Russian economy and the related strongly disturbed background of transient processes bear no fewer threats. The profound and protracted crisis that swept Russian industrial enterprises has involved a dramatic slowdown in production volumes and degradation of their resources, which has led into the disturbance of enterprise stability and fatal consequences for many of them. In such an extreme situation quite a number of industrial enterprises have been affected by the systemic crisis, fated for destructive restructuring and turned out to be on the verge of survival and bankruptcy.

Such challenges have determined relevance and usefulness of creating and approving the concept and technology of managing industrial enterprise stability and development. They are based on evolving and synthesizing the natural-scientific and economic knowledge and provided with the tools for processing and analyzing both the numeric and poorly formalized qualitative (heuristic) information to conduct monitoring of enterprise stability. Besides, their information resource establishes conditions for achieving the required value of enterprises' operation effect and providing its stability, and the level of knowledge influences their financial performance.

I cherish the hope that the research results, stated in the article, also have applied significance as they can be used both in management of industrial enterprises and in the state and regional management in the case of developing the industrial policy strategy and innovative Russian industrial development programs. The proposed theoretical provisions and methodological tools for management of stability and development of industrial enterprises are also addressed to colleagues from higher educational institutions and academic community who have been dedicated to studying the stated problems and teaching educational subjects on corporative management, management of knowledge, innovation management, state management, regional economics, etc.

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HOW TO GROW THE WORLD LEADER IN PHOTOVOLTAIC (THE CASE OF YINGLI SOLAR)

С.В. Ратнер

КАК ВЫРАСТИТЬ КОМПАНИЮ — МИРОВОГО ЛИДЕРА ФОТОВОЛЬТАИКИ (НА ПРИМЕРЕ YINGLI SOLAR)

This paper researches qualitative regularities of company development in the fast-growing sector of power engineering for solar energy. This subject is topical due to the strategic plans of developing renewable energy sources in Russia up until the year 2020 and the related prospects of establishing domestic manufacturing in the respective sectors of energy machine building with a primarily domestic market orientation. The chosen research method is a retrospective case-study of the development dynamics of the worldwide leader in photovoltaic element, unit and system manufacturing on the basis of polycrystalline silicon: the Chinese company Yingli Solar. The analytic materials of the European Photovoltaic Industry Association for 2009—2013, as well as the annual reports of the company for the period of 2006—2014, have served as the information base for the research. The article gives an efficiency rating to the corporate structure of the company, studies the market strategy and the innovative activity model of the company, and determines the primary factors of growth and competitiveness. Using the learning curve methodology we obtain quantitative ratings of learning rates in production and research activity of the company. We identify possible reasons for relatively low learning rates in production that the company has demonstrated during the researched period. The determined qualitative regularities of development of high-tech companies in new sectors of power engineering, as well as obtained quantitative ratings of learning in production and R&D, can be used for improving and correcting the strategic plans of renewable energy in Russia or for practical construction of high-tech business in the area of photovoltaics.

SOLAR ENERGY; PHOTOVOLTAICS; POWER ENGINEERING; LEARNING CURVE; CASE-STUDY.

Исследуются качественные закономерности развития компаний в быстрорастущем секторе энергетического машиностроения для солнечной энергетики. Актуальность выбранного исследования определяется стратегическими планами развития возобновляемой энергетики в России до 2020 года и сопряженными с ними перспективами создания отечественных производств в соответствующих секторах энергетического машиностроения с ориентацией, в основном, на потребности внутреннего рынка. В качестве метода исследования выбран ретроспективный кейс-стади динамики развития мирового лидера по производству фотоэлектрических элементов, модулей и систем на основе поликристаллического кремния китайской компании Yingli Solar. Информационной базой исследования послужили ежегодные отчеты компании за период 2006—2014 гг., а также аналитические материалы Европейской ассоциации индустрии фотовольтаики (European photovoltaic industry association, EPIA) за 2009—2013 гг. В статье дана оценка эффективности корпоративной структуры компании, изучены стратегия завоевания доли рынка и модель инновационной деятельности компании, выделены основные факторы роста и конкурентоспособности. Согласно методологии кривых обучения получены количественные оценки темпов обучения в производстве и научно-исследовательской деятельности компании. Идентифицированы возможные причины сравнительно низких темпов обучения в производстве, продемонстрированных компанией на протяжении исследуемого периода. Выявленные качественные закономерности развития высокотехнологичных компаний в новых секторах энергетического машиностроения, а также полученные количественные оценки темпов обучения в производстве и НИОКР могут быть использованы как в процессе доработки и коррекции стратегических планов развития возобновляемой энергетики в России, так и в практике построения высокотехнологичного бизнеса в сфере фотовольтаики.

СОЛНЕЧНАЯ ЭНЕРГЕТИКА; ФОТОВОЛЬТАИКА; ЭНЕРГЕТИЧЕСКОЕ МАШИНОСТРОЕНИЕ; КРИВАЯ ОБУЧЕНИЯ; КЕЙС-СТАДИ.

Sanctions and restrictions imposed by Western countries against the most export-oriented and competitive sectors of the Russian economy, as well as the prolonged worldwide decrease in oil prices, have actualized the problem of searching for the most effective and safest ways of Russia's participation in the global production chains. The issue of import substitution in the last year

has taken a central place in scientific research and business forums of various levels. Most studies focus upon justifying the possibilities of production development in various branches of the economy that have either received certain temporary market advantages (decrease in competition, increase in consumer demand, reduction of market entry barriers) [1] or those that have a strong technological potential that has been accumulated during the Soviet era and still has not been fully realized [2−3]. Factually, these are either low-tech industries (agriculture, processing) or high-tech aerospace industry, defense industry and mechanical engineering traditional for our country. However, the issue of achieving the technological leadership (or, at least the level of technological development, which is enough to ensure economic security in a new situation [4]) in fast-growing industries such as solar and wind energy and, directly associated with them, power engineering, is not well-covered by the modern economic literature.

Energy industry and power engineering at the present stage of development of the national economic system have high market potential, including export, and play a backbone role in the Russian economy. However, due to the unavoidable (in the long term) change of the techno-economic paradigm in the power industry, the economic and political position of Russia in the world will greatly depend on how successfully new branches of the economy will develop, since they represent the «core» of the new technological paradigm, and it will declare whether the country will be able to hold leading positions on new energy markets or become a dependent importer [5].

This study focuses solely on investigating patterns in the development of high-tech companies in the new fast-growing industry of power engineering for solar energy. The main tasks are to determine the primary growth drivers and factors for the sustainable development of companies during the periods of stagnation or recession in the industry. The choice of the industry for research is explained by the following factors:

a) photovoltaics is a fast growing market: the Compound Annual Growth Rate (CAGR) of PV installations was more than 30 % between 2000 to 2014, despite some underproduction and overproduction crisis during this period [6];

b) worldwide prices for photovoltaic products have decreased during the researched period more than 5.5 times, which indicates the presence of strong learning and scale effects in the industry [7];

c) the Russian manufacturers (LLC «Hevel», OJSC «Rostovteploelectroproyekt», RAS JIHT, CJSC «Noviy solnechniy potok», OJSC «Quant» and others) possess the necessary production technologies for photovoltaic modules and systems as well as access to the developments of domestic scientific schools that allows increasing the performance of generating equipment several times in comparison to the best foreign alternatives [8−9].

In order to develop a possible vision of patterns for the stable growth on developing markets, information will be drawn primarily by the case-study method. The successful case of establishment and development on the global photovoltaic market is the Chinese solar panel manufacture Yingli Solar. According to [10], «a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident». It allows gaining some qualitative and quantitative information and learning lessons, which help in the theory development. What is of interest is the particular conditions that led to use the acquired experience in another location. Therefore, the aim of case studies under analytical generalization is to answer the following questions:

− What factors determine sustainability of the company over a long period, including the phases of growth and decline in the industry?

− What kind of strategy can be considered optimal for a company: export orientation or emphasis on the development of the internal market?

− Would a vertically integrated or a networked form of the production chain be better, and under which conditions?

− Would performing R&D, commercializing results or working with licensed technologies be preferable during early stages of the company development, and would that change overtime?

The annual reports of the company for the period of 2006−2014, found on the official company website (http://www.yinglisolar.com/en/), as well as the analytic materials of the European Photovoltaic Industry Association (EPIA) for 2009, 2011, 2012 and 2013 have served as our information base.
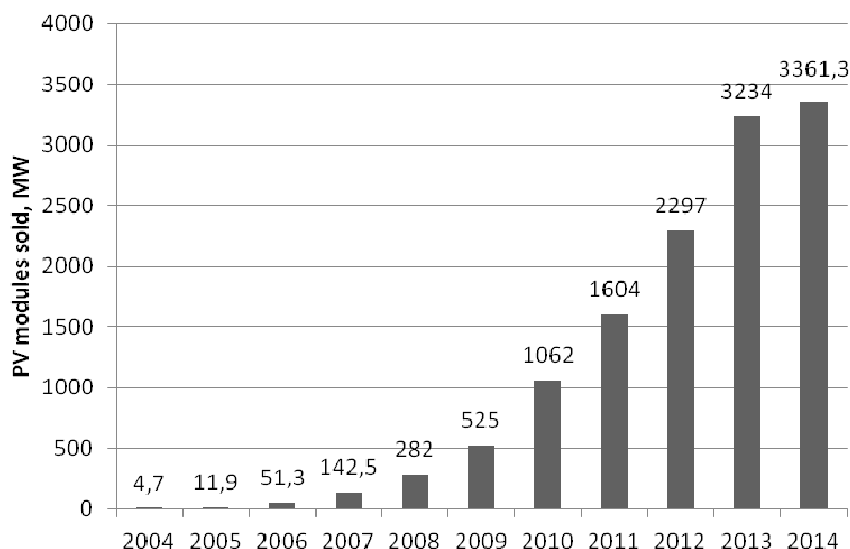
Fig. 1 Yingli Solar's shipment growth in 2004-2014.
Source: own analysis based on company's annual reports

The company started its operation in 2002 as a private entity named Chengdu Yingli, controlled by the Yingli Group financial group, involved in the development of the industrial park in Baoding. Chengdu Yingli began producing PV modules with an initial annual production capacity of three megawatts and significantly expanded production capacities of our PV products in the next five years. A high demand for the company products from foreign customers initiated the search for possibilities of quick expansion of production capacities and bringing in investors. The main source of financing during the initial period of the rapid production capacity growth (2004−2006) was the Chinese Tianwei Yingli company, a participant of the Yingli Group. In 2006 with the participation of Tianwei Yingli the company was incorporated in the Cayman Islands with the name Yingli Green Energy as part of a restructuring of equity interests in order to facilitate investments by foreign financial investors in Tianwei Yingli. In 2007 the company initiated IPO and hereby attracted a significant amount of private investment. By the end of 2014, the market capitalization of the company had been almost 500 million dollars. The Yingli Solar name became a recognisable brand and the production volume reached a record of 3361.3 MW/year (Fig. 1), which allowed the company to take up an 8.2 % share of the worldwide photovoltaic market.

Along with the growth of financial possibilities in 2005−2009, a vertically integrated structure was actively formed, later manufacturing capacity covered the photovoltaic value chain from ingot casting and wafering through solar cell production and solar panel assembly. In 2004−2005, Tianwei Yingli acquired a 50 % equity interest in Tibetan Yingli, the company that sells and installs PV systems. In July 2007, the company acquired a 30 % equity interest in Dongfa Tianying, which manufactures and sells tempered glass and accessories. The same year, an international branch of the company known as Yingli Green Energy Holding (International)[1] was founded [1], with marketing and logistics departments in Europe and production and research subsidiaries in China. The purposes of this branch were to export and promote products on international markets. Thus, the basis of the corporate structure of the company was fully formed (Fig. 2) and later underwent only minor changes.

In 2009, in order to decrease production costs and market risks associated with the increase in world prices for polysilicon, the Chinese Cyber Power and Fine Silicon companies were acquired, which used to be producers of solar-grade polycrystalline silicon. It was planned to substantially increase their production capacities. However, the overproduction crisis of polycrystalline silicon in 2011−2012 (which decreased its price from $200 to $14 per kg [11−12]) made the manufacture of polysilicon unprofitable and the company made a decision to close the Fine Silicon manufacturing capacity.

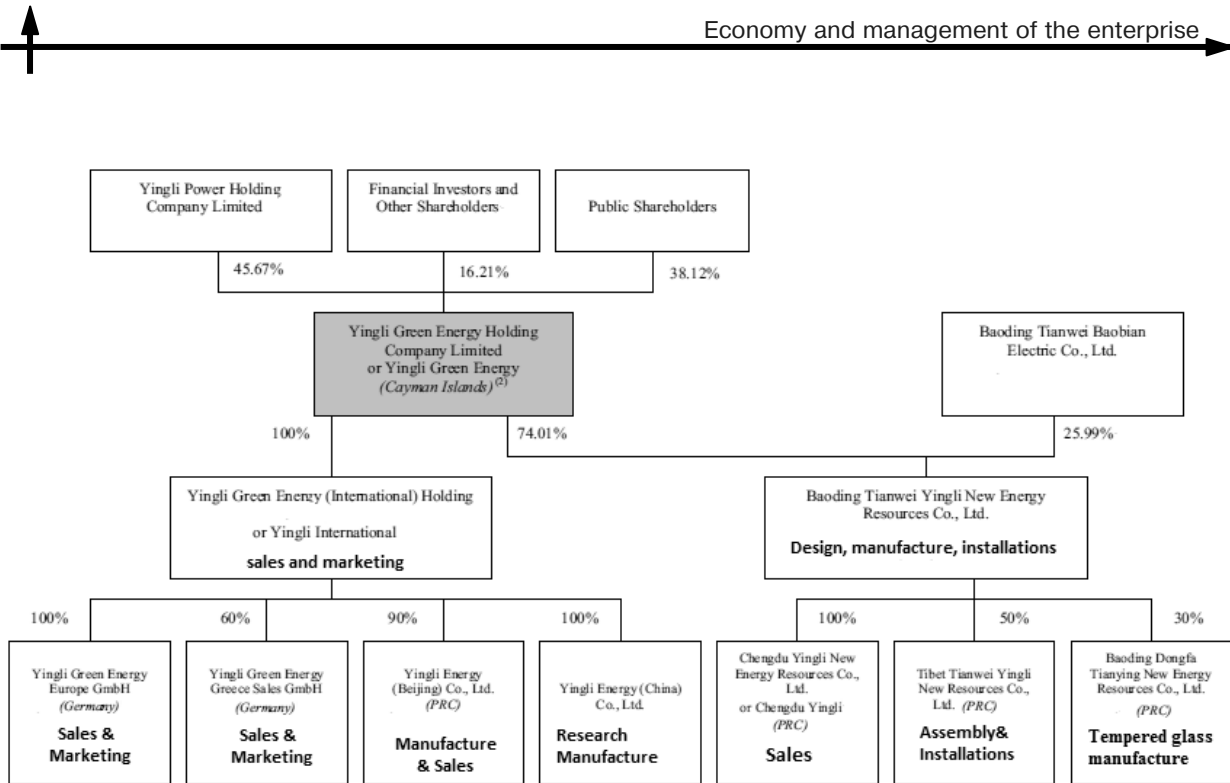---

[1] Shown in the figure as no. 2.

Fig. 2. The structure of Yingli Solar at the end of 2007
Source: own analysis based on company's annual reports

Another reason for building a vertically integrated structure is the company's commitment to quality control of production in all parts of the production chain. A rapid growth in demand for photovoltaic cells stimulated the development of a large number of related industries, not all of which are technologically and organizationally able to ensure the quality of their products. During the formation and rapid increase of production capacities in 2004, the company obtained an international certificate of compliance with the ISO 9001:200 standard for its quality management system, and kept the certificate up-to-date. From 2004 to 2007, the company repeatedly conducted tests of its products (inverters, modules and various models of photovoltaic systems) for compliance with IEC 61215 and obtained safety certificates of UL (USA) and TÜV (Germany). In 2011 the IEC 61215 compliance certificate was confirmed in the United Kingdom, Japan and Korea. Since the production of polycrystalline silicon ingots is associated with forming large amounts of wastewater and presents a potential risk for employee health, the company certified the relevant production divisions with the BS OHSAS 18001:2007 standard. The company also obtained the ISO 14001:2004 certificate in 2007 for the environmental management systems of all production divisions. The received certificates have been updated multiple times later.

The company's certification activity has achieved the expected results. Consumer confidence in the Yingli Solar brand has enabled the company to conquer new markets (Fig. 3).

In 2005, the lion's share of the company's products was exported to Germany (65.5 % of total revenues in 2005), but by 2014, the dependence on this major customer declined to 5.2 %, partly due to the emergence of regular customers in Japan (19.3 % of revenues in 2014), the UK (7.7 % of revenues in 2014), the Netherlands, the Czech Republic, Greece and South Korea. Diversification of sales markets allowed the company to maintain its leading positions during the sharp decline in demand for photovoltaic cells and modules due to scaling down state programs of solar energy support in several European countries and the US in recent years, as well as anti-dumping measures undertaken by the EU and the US against the cheap Chinese production in 2010−2013 [13−14].

An important factor in the company's success in this difficult period was also the rapid development of solar energy in China, which thanks to government incentive programs caused the rapid growth of demand for the company's products in the country (Fig. 4).

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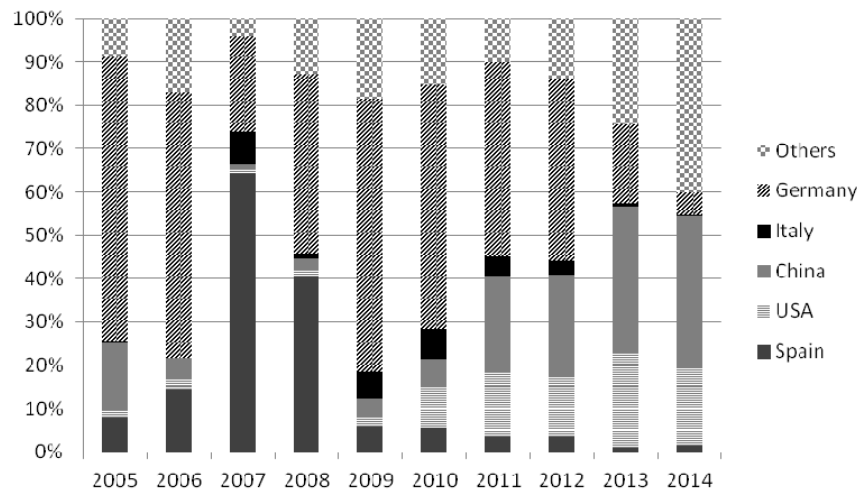
Fig. 3. Main markets of Yingli Solar in 2005−2014
Source: own analysis based on company's annual reports
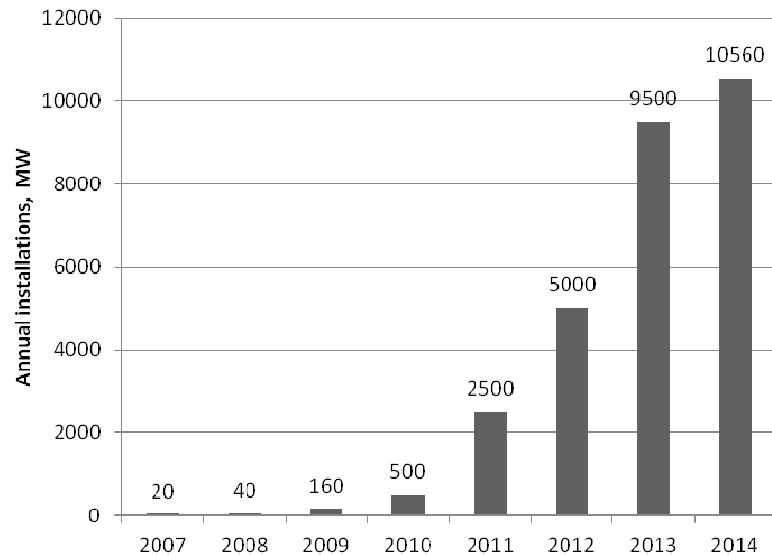
Fig. 4. Annual PV Installations in China in 2007−2014
Source: Technology Roadmap: Solar Photovoltaic Energy − 2014 edition. IEA, 2015.

The reorientation on the domestic market that took place in 2011−2012, allowed Yingli Solar not only to avoid reducing production, but even to gradually increase it (Fig. 1) Given the fact that the country currently ranks second in the cumulative installed capacity (after Germany), and by 2017 the Chinese government plans to increase the cumulative capacity to 70 GW [15], the company is currently primarily oriented to the domestic market, with gradual access to emerging markets in other world regions, such as Latin America, Middle East and Africa.

The well-known factors of cost cutting are usually economies of scale through large-volume manufacturing, learning-by-doing and improving in technical efficiency, which refers to Research & Development and is sometimes called «learning-by-doing in R&D». The learning curves can be built on statistical data about the Yingli Solar annual performance, collected from financial reports and presented in Table.

A slight increase in unit costs occurred in 2005−2006 due to a significant rise in prices for polysilicon, which is the most important raw material used in the PV-cells manufacturing process. Further cost reduction demonstrates effects of the economies of scales through large-volume manufacturing, and learning-by-doing.

Indicators of Yingli Solar's industrial activity

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PV modules sold, MW	11.9	51.3	142.5	282	525	1062	1604	2297	3234	3361.3
Net revenue, mill. RMB	362	1639	4059	7553	7255	12500	14668	11392	13418	12927
Cost of revenue, mill. RMB	254	1186	3102	5923	5540	8347	12228	11761	11959	10689
Unit expenses (per watt in RMB)	21.3	23.1	21.8	21.0	10.5	7.9	7.6	5.1	3.7	3.2
R & D expenses, mill. RMB	1.791	23.14	17.54	57.25	184.3	137.52	284.9	187.54	288.59	573.8
Average selling price of PV modules (per watt in USD)	3.49	3.82	3.87	3.88	2	1.75	1.43	0.77	0.55	0.52
Cell conversion efficiency (average), %	n/a	n/a	n/a	15.6	16.2	16.5	17.0	17.3	17.5	17.8
Cell conversion efficiency (PANDA pilot lines), %						18.5	19.0	19.4	19.8	20.2

Source: compiled by the author according to the annual reports of the company.

The learning rate, estimated according to the Boston Consulting Group methodology [16−17] is 6.2 %, which is quite low, comparing to average learning rates in photovoltaic, estimated in most souses as high as 20 % [18]. The most likely explanation of this fact is that the company had to undergo a crisis period with the collapse in polysilicon prices, when the production facilities of Yingli Solar were basically idle, and long-term contracts with suppliers of raw materials signed during the periods of the polycrystalline silicon price growth with the future transaction scheme became extremely unprofitable [14]. It should also be noted that the manufacturing cost also includes the warranty price, according to which within 10 years of operation the efficiency of photovoltaic modules cannot decrease by more than 10 %, and within 25 years − no more than 20 %. At the beginning of the production activity, the warranty hardly contributed to company's costs, however, later its share has increased. In 2012 the warranty costs amounted to 12.3 million yuans, in 2013 and 2014 that value has increased to 14.3 and 39.3 yuans respectively [19].

Another factor that affected the pace of training in the production is China's tightening the environmental legislation. For example, in 2014 the provincial government of Hainan suspended activities of three product lines divisions of Hainan Yingli because the company's environmental impact assessment system was considered inadequate for the new rules. However, Hainan Yingli managed to solve this problem in just three months and obtain permission to restart production as well as avoid a 0.28 million RMB fine [19].

It should be noted that the company started active research only in 2009, with the launch of the PANDA research project. During 2002−2008, Yingli Solar could be considered a low-tech company, since its R&D coefficient ranged between 0.41−0.75 % [20]. The share of R&D personnel did not exceed 5 % of the total number of employees. Yingli Solar had no international or Chinese patents, and its production technologies were protected merely by a trade secret.

The sharp increase in spending on R&D since 2009, as well as an increase in the research staff share up to 8 %, has led to a significant progress in the photovoltaic cell manufacturing technology. The average energy conversion coefficient increased from 15.6 in 2008 to 17.8 in 2014, and the experimental equipment manufactured as part of the PANDA research project reached the record of 20.2 %[2] [2]. Other indicators of the technological progress are the decrease in silicon wafer thickness (from 325 microns in 2003 to 130 in 2014) and increase in silicon ingots (240 kg in 2003, 800 kg in 2014). Since 2009, the R&D intensity coefficient of the company is 1.1−2.54 %, and in 2014, it reached 4.44 %, which allows attributing the company to the medium-tech sector. Along with the R&D development, the company started the patent activity: in 2009, Yingli Solar owned 34 Chinese patents, but the number increased to 1171 in 2014.

Considering the energy conversion factor of the photovoltaic cells as the primary indicator of

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[2] Energy conversion efficiency of solar cells produced in the laboratory, reached in 2014 a record for this type of technology index of 21.5 %.

the technological progress, and applying well-known methods of evaluating learning rates in R&D with a simple logistic curve [21], we'll obtain the rate of learning in Yingli Solar R&D equal to 2.8 %. This means that with doubling the cumulative volume of investments in R&D, the efficiency of solar cells produced by the company increases by 2.8 %. Note, that this value is significantly higher, for example, than that of the American manufacturer of cadmium-tellurium based photovoltaic cells, First Solar [22].

Conclusions. After analyzing the activity of Yingli Solar, we can define the following most important drivers of the company growth:

1) Increasing production and capacity growth actively started at the same time as the period of growing the demand for the company's products, which was related to forming and developing solar energy as a full-fledged branch of the global economy with investment and market volumes comparable to those of other commercially mature high-tech industries, such as civil aircraft industry [3].

2) Creating a vertically-integrated structure at the stage of the intensive (and, quite often, chaotic) growth in the number of manufacturers of similar products allowed the company to reduce costs associated with the procurement of raw materials and to provide quality control on all parts of the production chain. This increased consumer confidence in the brand and helped to diversify the geography of sales.

3) During the crisis period in the photovoltaic sector, which was caused by the oversupply and a shrinking demand, leading to a drop in prices for solar cells and modules, the company was able to shift to the growing domestic market and even to increase production volumes. This allowed maintaining the conditions for the effects of scale and training in production, being the primary factors of competitiveness in high-tech business [3, 7, 18].

4) In the context of increasing competition in the photovoltaic cell/module production sector, the company opted for the innovative development and achieved a significant increase in functionality of its products through an increase in R&D intensity. The increase in the research activity has led to significant changes in the intellectual property protection policies of the company.

Despite the fact that unique historical conditions of Yingli Solar's development are unlikely to reoccur or be reproduced artificially, the analysis

of company's experience and its comparison with the results of the research (e. g. [22]) allows identifying some qualitative patterns. In particular, it is notable that the feasibility of targeted domestic or foreign markets depends solely on the current situation in the relevant markets. A stable domestic market with transparent and clear strategic development goals can become a certain guarantee of viability, regardless of the situation on foreign markets and protectionist activity of other states. However, to achieve global competitiveness, the domestic market capacity needs to be large enough to provide conditions for the effects of scale and learning in production.

Considering the optimal corporate structure of companies in the renewable energy industry, it can be noted that in the period of production formation, establishment and improvement of the production process and increasing capacities, a vertically integrated structure allows reducing costs and ensuring quality control. However, once the branch (or a particular sector) achieves technological maturity and the price competition increases, a vertically integrated structure may become ineffective.

Innovation activation becomes necessary to maintain leading positions at a certain point of the branch development, which is determined by the technological maturity. However, up to that point, the strategy that is aimed at increasing production and conquering new markets by lowering prices and improving product quality remains viable.

Policy Implications. In the coming years, Russia plans to develop its own renewable energy production (e. g. [23-24]), oriented, primarily, to the domestic market. However, the pace of growth of domestic demands for energy products, currently stated in governmental documents (including the draft of the Russian energy strategy until 2035, which is currently at the expert approval stage), may be insufficient to ensure competitiveness of Russian manufacturers, primarily in the price performance. The identified qualitative patterns in the high-tech company development in new sectors of power engineering, as well as the quantitative assessment of the training pace in production and R&D can be used to revise and correct strategic plans for the development of renewable energy in Russia, as well as in practice, to create high-tech photovoltaic businesses.

Areas for further research. Given the fact that the development of solar energy and power engineering for solar energy occur rapidly, the obtained quantitative estimates of learning rates in R&D need to be reviewed and updated along with the publication of new statistics on the technological progress in the field of solar energy conversion. In addition, in order to improve reliability of the results, the identified qualitative patterns of Yingli Solar's development can be compared with the patterns of other leaders in the industry.

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IT PROJECTS FEASIBILITY ASSESSMENT
AS AN ALTERNATIVE TO ECONOMIC EFFICIENCY ASSESSMENT

Н.Н. Шляго

ОЦЕНКА ЦЕЛЕСООБРАЗНОСТИ ВНЕДРЕНИЯ IT-ПРОЕКТОВ
КАК АЛЬТЕРНАТИВА ОЦЕНКЕ ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ

Assessment of the practicability of IT projects deployment in business practices is just one element in the group of computerization issues. Today, this task is solved through determination of economic efficiency of an IT project. Techniques used for assessing economic efficiency turn out rather labor-intensive, expensive and do not provide a reliable assessment of IT impact on company performance, which brings into question their value and validity. Seeking to share information on the specific features of ICT deployment processes, the article offers a brief description of techniques currently used by Russian businesses to justify practicability of introducing information technologies. The article also describes a new approach to assessing the practicability of computerization of a business entity based on the conceptual framework that is different from conventional profit-oriented philosophy. Using the concept of a company's target image that combines the targets of growth, development and profit, this article proposes a model for justifying the practicability of IT deployment based on the priority of growth target. Computerization option that maximizes the company's sale volume shall be determined through monitoring the operational safety level, provided a number of additional constraints are met. The model uses a modified breakeven point formula that takes into account the multivariable function of costs. The model is based on a number of assumptions, is fairly simple and considered as a possible express analysis technique for selecting the option of computerization. The proposal is up for further discussion. Evolution of the concept of assessing the practicability of IT projects deployment in business practices based on the target image is envisioned through the search of indicators and criteria that demonstrate the impact of IT on the attainment of the third target, i. e. development.

IT PROJECT; ECONOMIC EFFICIENCY; TARGET IMAGE; GROWTH TARGET; OPERATIONAL SAFETY LEVEL.

Оценка оправданности внедрения IT-проектов в практику бизнеса является одним из элементов совокупности проблем информатизации. Сегодня эта задача решается путем определения экономической эффективности IT-проекта. Методики оценки экономической эффективности на практике оказываются трудоемкими, дорогостоящими и не позволяющими в достаточной степени надежно оценить степень влияния IT на результаты деятельности компании. Это ставит под вопрос их ценность и оправданность применения. В целях обмена информацией об особенностях процессов внедрения ИКТ приведена краткая характеристика методик, используемых в настоящее время российскими компаниями для обоснования целесообразности внедрения информационных технологий. Предложен новый подход к оценке целесообразности информатизации бизнеса, основанный на концептуальной основе, отличной от общепринятой ориентации на прибыль. Отталкиваясь от концепции целевой картины компании, объединяющей цели роста, развития и прибыли, в данной статье предложена модель обоснования целесообразности внедрения IT, предполагающая доминирование цели роста. Определение варианта информатизации, максимизирующего объем реализации компании, осуществляется под контролем показателя уровня операционной безопасности при соблюдении ряда дополнительных ограничений. В модели использована модифицированная формула точки безубыточности, учитывающая многофакторность функции затрат. Модель построена на ряде допущений, является простой и рассматривается как возможный способ экспресс-анализа при решении проблемы выбора варианта информатизации. Предложение внесено для дальнейшего обсуждения и дискуссий. Дальнейшим расширением концепции оценки целесообразности внедрения IT-проектов в практику бизнеса на основе целевой картины представляется поиск показателей и критериев, отражающих влияние IT на достижение третьей цели — цели развития.

IT-ПРОЕКТ; ЭКОНОМИЧЕСКАЯ ЭФФЕКТИВНОСТЬ; ЦЕЛЕВАЯ КАРТИНА; ЦЕЛЬ РОСТА; ОПЕРАЦИОННЫЙ УРОВЕНЬ БЕЗОПАСНОСТИ.

Introduction. Today ICTs are most commonly characterized from the perspective of success in the IT industry. This includes forecasting the IT products market growth and market structure change, as well as analyzing the results. In all the developing economies IT market growth caused

by the overall slowdown of average global economic growth continues despite a certain decline.

Still the agenda of processes computerization is not restricted merely to learning the prospects of the ICT market. Some other important tasks include finding how much IT affects the economy in general and searching for the best techniques to assess practicability of deploying IT projects by companies.

The former task is associated with the Solow paradox that came to light in the end of the 20th century. As we know, the paradox of R. Solow [1] and the article by E. Brynjolfsson [2] put into question the efficiency of investment in IT on the brink of the 21st century. Still, the development of general-purpose technologies concept [3−4], as well as the results of empirical studies obtained in the early 21st century based on the new ideas [5], have already confirmed the efficiency of investment in IT assets. However, researchers believe that the existence of this relation needs to be confirmed for each individual country.

The latter task rises from the existence of a wide range of methods used for calculating the economic efficiency of IT projects [6−7], which in itself proves that nobody has proposed a valid method as of yet. This leads to the following question: why don't we look for other ways to solve this problem?

This article intends to provide a brief outline of techniques currently used by Russian businesses to justify the introduction of information technologies. At the end of the article, the authors also propose a new approach to assessing the feasibility of computerization based on a conceptual framework that is different from conventional profit-oriented philosophy.

Techniques in assessing the economic efficiency of IT deployment in Russian business practices today

There is hardly any doubt that information technologies are a must-have for corporations today. Still, there are both fierce supporters of computerization of business and those who look at this with skepticism, especially when it comes to small businesses. A study in computerization processes in the Russian business domain indicates that «the attitude of business owners and executive officers to IT is rather mixed. One see IT as a fashion trend that is to be followed only because everyone does today, and for others

IT means good image and one of the means to increase the value of company's assets. Still, there are much more entrepreneurs who see information technologies exclusively as a source of trouble and needless incidental expenses» [8, p. 2].

Situations when company management decides to deploy certain information products may be just as alarming. A decision to purchase an information system (IS) is often based on such criteria as

«1. The name of the IS recently deployed by a successful competitor.

2. The first result in a search engine with a bright description of unlimited capabilities of a new product on the software market.

3. An earnest narrative by a computer outlet manager or work fellow, or a cover of a promotional booklet accidentally seen on the desk. This list of options is far from being conclusive» [9, p. 23].

It is interesting to note that assessment of management processes computerization efficiency is not a new issue. Russian researchers and enterprises of the 1970s and 1980s focused extensively on developing the methodology and discussing economic efficiency of management computerization (e. g., see [10−12]). Of course, these techniques were developed for the economic mechanism in place at that time. Still, one of the essential issues of computerization that was identified then and remains relevant to this date is the question why the efficiency increased − was it a result of information technologies deployment or did it occur after the re-engineering of business processes driven by the computerization.

Today, techniques based also on the evaluation of economic efficiency and primarily developed in the West prevail among the tools used to assess the practicability of implementing information technologies. A wide range of approaches has been developed for assessing economic efficiency [6−7]. Admittedly, financial techniques are employed predominantly. These are mostly the techniques that can be referred to as conventional, including the ROI and EVA calculation. Another technique that has become very popular these days is the TCO (Total Cost of Ownership) assessment developed by Gartner Group research company. Other popular techniques include the TEI [13] and REJ (Rapid Economic Justification) methods developed by Microsoft. In addition to the financial techniques of assessing economic efficiency of information technologies, there are also

quality-based and probability-based techniques. The quality-based techniques include Balanced Scorecard system, IT Scorecard method and Portfolio Management technique, and the category of probability-based techniques is represented by Real Options Valuation (ROV) and Applied Information Economics (AIE) methods.

Some researchers classify the efficiency assessment techniques into comparative, cost and income methods [14], putting TCO into the category of cost methods, and ROI calculation − into income methods. In the latter case, income is understood as net profit from sales of a project. Comparative methods can be exemplified by the use of techniques described in [15]:

− comparison of IT costs as a percentage of company income with a group of similar companies (by activity profile or other criterion);

− comparison of IT costs as percentage of company income with other companies of similar size (in this case, size should be understood as sales volume of the company);

− comparison of IT costs per one employee of IT department with similar companies or for the market in general;

− assessment based on the P. Strassmann formula determining the correlation between the amount of IT budgets and the group of costs including management and administration, promotion and sales support (Sales, General & Administrative − SG&A) [16].

All of these approaches are employed in Russia. For example, TCO assessment is used in the field of healthcare information systems [17], and the TEI technique appears of great interest, as well, e. g., see [18].

However, comparative analysis of the above techniques carried out by different groups of researchers, both overseas, e. g., [7] and in Russia, e. g., [14, 17, 19], leads to the conclusion that it is fairly difficult to suggest the optimal method. Each technique has its advantages and constraints, and all of them are quite complex, labor-intensive and therefore expensive.

Russian researchers also take interest in the issues of justifying deployment of information technologies. The matters of economic efficiency of business computerization are studied from both theoretical and practical aspects.

The group of studies focusing on the theoretical aspects of the issue includes, among others, the studies of practicability of IT deployment

from the perspective of the institutional theory, e. g., papers by V. Platonov [20], R. Shchemelev [21] V. Ananyin [22−24]. Both theoretical and practical researchers focus extensively on the various aspects of employment of system analysis methods, specifically the hierarchy analysis method [19] developed by T. Saaty [25], a as well as the complex expertise models, e. g., see [26] based on the application of A.A. Denisov's [27] information approach. A number of studies on the use of information systems by companies increasingly state the importance of additional benefits resulting from computerization, which turns the IT into an intellectual resource of the company [18, 28]. To be more accurate, based on the current terminology that reflects the nature of knowledge approach [29], information technologies and knowledge bases are seen as an element of structural capital that encourages the development of human and client capital, thus adding to the overall value of the company.

Determination of the impact of information technologies on business efficiency indicators is the priority field of research today These issues have been reflected in both theoretical [20, 21, 24] (Platonov, 2007; Shchemelev, 2009; Ananyin, 2010) and empirical studies by Russian scientists. Results of empirical studies based on the E. Brynjolfsson [5] technique were demonstrated in the course of IT-Value.ru project and confirmed both the correlation between IT budget and the amount of business and administrative costs for Russia, and the efficiency of investment in IT assets in Russia [30].

In addition to theoretical and empirical studies, various techniques for assessing the economic efficiency of IT projects are being developed, and each of these techniques has certain highlights. For instance, authors of the [31] method assume that efficiency of management computerization may be expressed «not only in economic values of performance of the enterprise, but also in technical values typical for an information system as a software package. Thus, the nature of efficiency of a management information system is dual, and both of its aspects are closely related with each other.» The use of information systems is now seen as a way to support and manage the information operations of a business [32]. The study by [33], IT products are viewed as a tool for re-engineering of business processes. The assessment of company performance

resulting from such re-engineering is proposed by benchmarking the resulting values of performance indicators with the forecasted business indicators calculated as suggested by W.W. Jekkerson [34]. On the other hand, the study by [9] offers a technique based on the systemic approach, re-engineering of business processes and qualimetric analysis method.

These techniques try to incorporate the benefits that may result from the implementation of IT, but they also demonstrate that the impact of information technologies on company performance is not always obvious and mostly mediated.

Consequently, with all the diversity of existing approaches to economic efficiency assessment, corresponding assessment techniques are usually cumbersome, expensive and do not take into account the impact of IT on the company performance. These shortcomings are specifically prominent for small businesses that would like to use an easier way for justifying the deployment of IT.

In addition to these purely practical considerations, there is also a question of why the justification of IT implementation is considered from the perspective of economic efficiency. This approach is conventionally explained by the point that profit is the goal of any profit-making organization. Still, profit is not the only goal for business. Strategic view on company's operations is much wider.

IT technology implementation practicability assessment based on the assessment of operational safety level

Target image as a complex of basic target areas of business represents a key element of a company's qualification from the strategic viewpoint. Controlling focuses extensively on this target image today. For example, the studies of A. Dale [35, p. 17], one of the most reputed ideologists of controlling, view the target image of a company as a complex of targets of growth, development and profit. It is important to understand that these targets must be balanced in the long run, but one of the targets takes priority in the short term. More often than not, a business puts growth as such prevailing target, i. e. it seeks to increase production and sales of products (services) that are already recognized in its business programme.

As a follow-up of this approach, this article proposes a technique for assessing practicability of IT implementation that relies on the following basic provisions:

1. Growth of sales volume (products or services) is considered the prevailing target.

2. Different computerization options are considered as free variables. For the sake of simplicity, let us presume that each option is determined by two parameters (e. g., various options of new equipment and various options of communication expenses).

3. A sales growth factor is attributed to each computerization option. It is presumed that company employees are capable of achieving the potential of forecasted sales increase.

4. Constraints include the company's production capacity and the amount of funds that company management is ready to spend on computerization.

5. Operational safety level is used as the criterion for selecting the optimal computerization option.

When a company focuses on the growth target, operational safety level may become a good criterion for selecting the subject of investment:

$$F = (Q - Q^*) / Q \cdot 100, \qquad (1)$$

where F is the operational safety level (%), Q is the expected amount of business (ea/period), and Q^* is the breakeven point (ea/period).

Traditionally,

$$Q^* = C_{fix} / (P - C'_{var}), \qquad (2)$$

where C_{fix} is fixed costs (monetary unit/period), P is price (monetary units), and C_{var} is specific variable costs.

Clearly, the higher the positive value of operational safety level F, the better it is from the perspective of the growth target. Breakeven point in this case represents a sort of economic guarantee. Then the problem of IT selection will, generally speaking, look as follows: find the computerization option (ij) that takes the company to

$$\max Q_{ij} \qquad (3)$$

given that

$$Q_{ij} \leq M, \qquad (3a)$$

$$K_{ij} \leq K, \qquad (3b)$$

$$F(Q_{ij}) \geq F_0, \qquad (3c)$$

where M is the production capacity, K is the amount that the company management is ready to spend on computerization, (ij) is the computerization option index, Q_{ij} is the sales

volume in case of the (ij) option, F_0 is the lower limit of operational safety level that company management deems satisfactory, and K_{ij} is the amount of investment for the (ij) option,

$$K_{ij} = B_i + L_j, \qquad (4)$$

where B_i is the i − value of $\mathcal{B}$ − first element of the IT package (money units), $i = 1, ..., I$; L_j is the j − value of $Д$ − second element of IT package (money units), $j = 1, ..., J$.

However, it is difficult to determine the breakeven point in this case, while normally its calculation is based on the assumption that costs are a function of only one variable − amount of business: $C = f(x)$, which gives rise to two kinds of cost − fixed and variable, i. e. $C = C'_{var} \cdot Q + C_{fix}$.

In our case, there will be two more drivers impacting cost in addition to the amount of business, i. e. the options of each two elements of the IT package. Thus, cost becomes a function of several variables $C = f(x_1, x_2, ..., x_n)$. Let us assume that the value of these options impacts the value of fixed costs only, i. e. the breakeven point formula will include a variable value of fixed cost (C_{fixij})

$$C_{fixij} = C_{fix} + B_i + L_j. \qquad (5)$$

Consequently, the following modified formula can be used to calculate the breakeven point:

$$Q^{**}_{ij} = (B_i + L_j + C_{fix})/(P - C'_{var}) = \\ = Q^* + (K_i + L_j)/MR', \qquad (6)$$

where C_{fix} is the basic fixed cost (monetary unit/period); P is the product unit sale price (monetary units); Q^{**}_{ij} is the modified breakeven point for the i-value of factor $\mathcal{B}$ and j-value of factor $Д$; Q^* is the conventionally calculated breakeven point (for C_{fix}); MR' is the specific marginal revenue, $MR' = P - C'_{var}$.

Let us introduce the following coefficients to take into account the impact of IT on sales growth:

kb_i − coefficient of company sales volume increase due to the i-factor (element $\mathcal{B}$),

kl_j − coefficient of company sales volume increase due to the j-factor (element $Д$)

And now let us make another assumption: the two factors collectively give rise to the synergy effect, and the sales growth process becomes more intensive. The synergy effect is introduced by the following coefficient:

kc − coefficient of synergized sales growth.

Consequently, the forecasted sales volume (Q_{ij}) will be calculated as follows:

$$Q_{ij} = Q_0 \cdot kb_i \cdot kl_j \cdot kc, \qquad (7)$$

where Q_0 is the basic value of sales volume.

The most convenient way to solve this problem is by arranging the values in a table.

Let us look at the following example.

Let us say that company operations may be described as follows: $P = 10$ m. u.; Q_0 − initial sales volume equals 700 ea/period, $C'_{var} = 4$ m.u./ea., $C_{fix} = 2.000$ m. u./period, $M = 935$ ea./period, $K = 750$ m. u., and $F_0 = 30$ %. $MR' = P - C'_{var} = = 6$ m. u./ea.

It is then obvious that $Q^* = 334$ ea., and $F = 52.4$ %, which is a good figure. At the same time, company management thinks that market demand allows engaging extra clients and increasing sales volume through the deployment of an IT product.

Let us presume that the company considers three options of using the $\mathcal{B}$ element and four options of using the $Д$ element. Cost estimates for these options are provided in Tab. 3. We will then use formula (5) and basic values of fixed cost ($C_{fix} = 2000$ m. u.) to obtain the modified values of fixed cost (see Tab. 1).

Table 1

Values of modified fixed cost (C_{fixij}), m. u./period

		L_j, Options of the second package element, m. u.			
		50	75	150	200
B_i Options of the first package element, m. u.	400	2450	2475	2550	2600
	600	2650	2675	2750	2800
	900	2950	2975	3050	3100

Now, we will use formula (6) to determine the corresponding values of the modified breakeven point (Tab. 2).

Table 2

Values of modified breakeven point (Q^{**}_{ij}), ea/period

		L_j, Options of the second package element, m. u.			
		50	75	150	200
B_i Options of the first package element, m. u.	400	408	413	425	433
	600	442	446	458	467
	900	492	496	508	517

Table 3

Forecasted sales volume (Q_{ij}), ea/period

			L_j, Options of the second package element, m. u.			
		kl_i	1.01	1.015	1.03	1.01
	kb_i	L_j / B_i	50	75	150	200
B_i Options of the first package element, m. u.	1.1	400	856	860	872	856
	1.12	600	871	875	888	871
	1.2	900	933	[937] 935	[951] 935	933

Next, we will present the calculated results of forecasted sales growth based on formula (7) (Tab. 3). Values of coefficients kb_i and kl_j are also provided in Tab. 3. Let us presume that synergized growth coefficient $kc = 1.1$.

Sales volume forecast shows that options (B_3, L_2) and (B_3, L_3) do not meet formula (3a), because production capacity $M = 935$ ea/period. Therefore, when calculating the operational safety level for these options, forecasted sales volume is assumed to be equal to production capacity, i. e. $Q_{32} = Q_{33} = 935$ ea/period. Let us calculate the operational safety level using formula (1), with conventional safety point (Q^*) replaced by the modified safety point (Q^{**}_{ij}). Calculation results are shown in Tab. 4. The same table contains the details of investment amounts for option (ij) that are calculated using formula (4).

Now, based on formula (3b), we will discard all the options that do not meet this formula. For example, if $K = 750$ m. u., then all options where $K_{ij} \geq K$ will be discarded (see Tab. 5).

Table 4

**Operational safety level (F_{ij}), %
and investment amounts (K_{ij}), m. u.**

K_{ij}		L_j, Options of investment in personnel development, m. u.			
	F_{ij}	50	75	50	200
Bi Options of the first package element, m. u.	400	450 / 52.3	475 / 51.9	550 / 51.3	600 / 49.2
	600	650 / 49.3	675 / 49.0	750 / 48.4	800 / 46.5
	900	950 / 47.4	975 / 47.0	1050 / 46.5	1100 / 44.6

Table 5

**Revised table of operational safety levels (F_{ij}), %
and forecasted sales volume (Q_{ij})**

Q_{ij}		L_j, Options of investment in personnel development, m. u.			
	F_{ij}	50	75	150	200
B_i Options of the first package element, m. u.	400	856 / 52.3	860 / 51.9	872 / 51.3	856 / 49.2
	600	871 / 49.3	875 / 49.0	888 / 48.4	
	900				

Note the resulting operational safety level in all the calculated options is lower than the initial value $F = 52.4$ %. Still, given that the minimum threshold is $F_0 = 30$ %, all the options are considered acceptable based on formula (3a). In this case, Q_{ij} reaches its maximum under options (2, 3). If the company management is prone to risk, it may choose the option with the amount close to optimal, but with higher operational safety level. This will be option (2, 2), where $Q_{22} = 875$ ea. and $F_{22} = 49.0$ %.

As a result, we solved the problem and chose the option of an IT package that would enable maximum possible sales based on the growth target with the designated values of production capacity, acceptable operational safety level and the amount of funds that the management is ready to use for IT implementation.

The proposed calculations are based on a number of assumptions:

– it is possible to assess the increase in sales caused by the use of IT systems. Forecasting the sales volume is one of the most complex issues, and this problem is often solved using the statistical data or expert evaluations;

– only fixes costs change after computerization. In reality, IT have an impact on variable costs, as well, and the proposed calculation pattern can be modified to take into account this factor;

– company employees will be able to fully unlock the potential offered by the purchased IT system. Management computerization must come hand in hand with personnel development, and not only in computer technologies, but also in the knowledge of economy.

Results obtained after solving the above example shall not be used as a basis for any deductions

regarding the behavior of parameters considered in this model. The purpose of these calculations was only to demonstrate the calculation pattern.

This method should be considered as a possible express analysis technique for selecting the option of computerization.

Conclusion. This article intends to provide a brief outline of techniques currently used by Russian businesses to justify the implementation of information technologies.

This has a long history and there have been significant findings behind the theoretical and practical studies of economic efficiency assessment in Russia, but the transition to a new economic mechanism brought about the need of new methods that better meet the new requirements.

Techniques based on the determination of economic efficiency and often developed in the West are now used in Russia for assessing the practicability of IT implementation.

At the same time, Russian researchers study foreign practices, test them with Russian realities and develop their own approaches to assessing the practicability of IT deployment.

Most techniques that focus on the assessment of economic efficiency turn out rather labor-intensive, expensive and do not provide a reliable assessment of IT impact on company performance, which brings into question their value and validity.

Using the concept of a company's target image that combines the targets of growth, development and profit, this article proposes a model for justifying the practicability of IT deployment based on the priority of growth target.

A computerization option that maximizes the company's sale volume shall be determined with monitoring of operational safety level, provided a number of additional constraints are met.

The model uses a modified breakeven point formula that takes into account the multivariable function of costs.

The model is based on a number of assumptions, is fairly simple and considered as a possible express analysis technique for selecting the option of computerization.

The proposal is up for further discussion. Evolution of the concept of assessing the practicability of IT projects deployment in business practices based on the target image is envisioned through the search of indicators and criteria that demonstrate the impact of IT on the attainment of the third target, i. e. development.

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ANALYSIS OF ADAPTIVE INSTITUTIONAL REGULATION OF SOCIOECONOMIC DEVELOPMENT OF TRADE ENTERPRISES

Т.А. Переверзева, М.К. Евдокимова

ИССЛЕДОВАНИЕ АДАПТИВНОГО ИНСТИТУЦИОНАЛЬНОГО РЕГУЛИРОВАНИЯ СОЦИАЛЬНО-ЭКОНОМИЧЕСКОГО РАЗВИТИЯ ПРЕДПРИЯТИЙ ТОРГОВЛИ

In the light of growing economic development and constantly changing market conditions the effectiveness of trade enterprises becomes a key point of organization's strategy and dictates the need for faster adaptation to the external environment. The article under review evaluates the relevance of this topic and explores the problem of adaptive institutional regulation of trade enterprises. The authors define the object and its structure, goals, tools, the algorithm of institutional regulation and describe evolutionary and revolutionary scenarios of adaptive regulation. The study includes a new interpretation of the definition of 'adaptive mechanism', covers L.A. Rastrigin's and Y.Z. Tsipkin's viewpoints of the 'adaptation' definition, describes the types of adaptation goals, analyzes the tools of institutional adaptation in terms of the entrepreneurial goals and develops the algorithm of institutional status assessment for a trade enterprise. Institutional status assessment involves describing the set of norms and standards followed by the enterprise, specifically economic and social ones, and comparing them to the reference values. The deviation from the reference value, in its turn, becomes the incentive for the normalization of institutional status in the sphere of corporate finance, tax liabilities, planning, controlling etc. The results of this study can be used to correct the strategy of organization's development in order to minimize risks and increase stability. The optimal number of institutional tools of trade business regulation is related to the number of the development goals, unique for every business entity. This relation is described with Tinbergen's inequality, that shows the balance between the number of goals and the number of tools used to achieve them. If economic practice reveals inefficiency of adaptation tools, it compels the organization's management to make some changes in the norms and processes used by specific institutions: either to introduce new norms/processes or to improve the existing ones. The need for theoretical and methodological evaluation of institutional adaptation of trade enterprises is constantly increasing, especially because of their growing importance for making operational and strategic decisions regarding the development of trade business.

ADAPTIVE INSTITUTIONAL REGULATION; GOALS OF REGULATION; FORMAL AND INFORMAL TOOLS; MECHANISMS AND INSTRUMENTS OF INSTITUTIONAL ADAPTATION; INSTITUTIONS.

В связи с увеличивающимся темпом развития экономики и постоянно меняющимися условиями рыночной среды обеспечение эффективной деятельности торговых предприятий становится ключевым моментом их стратегии с необходимостью максимально быстрого приспособления к внешним условиям. В этом актуальность данного исследования, в связи с чем рассмотрены вопросы формирования адаптивного институционального регулирования предприятий торговли: обозначены объект и его структура, цели, инструменты и поэтапный алгоритм институционального регулирования; приведены описания эволюционного и революционного сценариев адаптивного регулирования. Приведен авторский взгляд на дефиницию «адаптивный механизм», представлены взгляды Л.А. Растригина и Я.З. Цыпкина на определение «адаптация», рассмотрены компоненты внешней и внутренней институциональной среды; обозначены виды целей, анализируется институциональный инструментарий относительно специфики поставленных перед предприятием целей, сформирован алгоритм оценки институционального состояния организации. Оценка институционального состояния предприятий включает описание используемого предприятиями нормативного массива в части экономических и социальных норм с учетом их соответствия эталону. В свою очередь, определение степени отклонения от эталона становится для организаций торговой отрасли стимулом для нормализации институционального состояния в сфере корпоративных финансов, налоговых обязательств, планирования, контроллинга и т. д. Результаты исследования могут применяться при корректировке стратегии предприятия в целях минимизации рисков и обеспечения более высокого уровня устойчивости. Вопросы нахождения оптимального числа институциональных инструментов регулирования торгового бизнеса увязаны с количеством целей развития хозяйствующих субъектов отрасли в рамках неравенства Тинбергена, показывающего соотношение целей и используемых для их достижения инструментов. В случае если экономическая практика хозяйствующих

субъектов показывает неэффективность инструментов адаптации, это заставляет руководство предприятия осуществлять изменение нормопроцессов внутри конкретных институтов — регуляторов, вводя новые нормопроцессы или совершенствуя имеющиеся. Потребность в теоретико-методических разработках вопросов институциональной адаптации предприятий торговой отрасли постоянно возрастает и особенно усиливается их значимость в процедурах принятия оперативных и стратегических решений по развитию торгового бизнеса.

АДАПТИВНОЕ ИНСТИТУЦИОНАЛЬНОЕ РЕГУЛИРОВАНИЕ; ЦЕЛЬ КАК ОРИЕНТИР РЕГУЛИРОВАНИЯ; ФОРМАЛЬНЫЕ И НЕФОРМАЛЬНЫЕ ИНСТРУМЕНТЫ; МЕХАНИЗМЫ И ИНСТРУМЕНТЫ ИНСТИТУЦИОНАЛЬНОЙ АДАПТАЦИИ; ИНСТИТУТЫ.

Forewood. Socioeconomic development of enterprises in the trade industry causes the need for continuous adaptation to new rules and norms of business relations. One of the most important aspects of the study of working relations in the field of circulation is the institutional one, i. e. the identification of prospects and registration of consequences of changes in internal and external environment factors in the light of specific set of standards in use, which allows us to increase the efficiency of business entities in the industry.

Scientific problem statement. The analysis of institutional adaptation of trade enterprises requires taking into account the importance of adapting to modern business standards and to the mechanisms and methods that enable this adaptation.

In this article we use a broader definition of adaptation mechanisms or tools of institutional adaptation which covers the whole set of procedures of analysis, planning, regulation and stimulation of trade enterprises. In this context business entities of trade industry can be considered the substructures of institutional adaptation system involving a wide spectrum of iterations for the development of the institutional status as well as the institutional strategy and policy.

The basic concepts of adaptive institutional regulation for the goals of this study are as follows: setting the object of adaptive institutional regulation and developing the *algorithm* of adaptive institutional regulation.

Analysis. In our opinion the general notion of adaptation to new conditions needs to be clarified. In this respect the opinion of L.A. Rastrigin seems quite relevant. His interpretation of adaptation and its types is following: «The concept of adaptation as an active action (management action) typically combines two meanings: adaptation to a fixed environment (later referred to as *passive adaptation*) and search for the environment adequate to the given system (later referred to as *active adaptation*). In the first case the adaptive system acts so as to perform its functions in the given environment the best way possible, i. e. maximizes its criterion of efficiency of functioning in the environment. Active adaptation, on the contrary, implies either changing the environment to maximize performance effectiveness criteria or active search for an environment in which the goal will be achieved. It is obvious that in reality both types of adaptation are used simultaneously and often interact with each other» [11, p.10].

The observations presented above provide an opportunity to view institutional adaptation in two different scenarios — evolutionary and revolutionary. This differentiation of institutional adaptation scenarios is quite common for trade industry entities — it implies, on the one hand, the adaptation to existing norms for trade organizations: social, legal, tax norms, etc., and, on the other hand, the reorganization of regulations themselves.

Speaking about the basic definitions of adaptive institutional regulation, first of all it is necessary to define the object of adaptive institutional regulation, i. e. the institutional environment, external and internal.

External institutional environment is the set of institutions affecting the trade enterprise from the outside. It is a reflection of current conditions of social development.

The study of the institutional aspects of trade organization development dictates the need for a wider approach to the interpretation of the institutions, in terms of which the institution is not only regarded as the norm of interaction between the economic agents or a set of specific standards and rules, but also as the organizational form of their association and regulation.

The general layout of institutions composing the external institutional environment can be represented by the federal institutions — general or trade ones or — and regional trade institutions [9, p. 76].

General federal institutions are the institutions of state power bodies which in accordance with

the laws of the Russian Federation exercise control over the trade with the purposes of protecting the rights of consumers, providing revenue for the government budget funds and ensuring food security for the population. External institutional environment is comprised of the multitude of norms produced by the institutions affecting the operations of the trade business, for example, Federal tax service of the Russian Federation /FTS/, Federal Antimonopoly service of the Russian Federation, the Federal Agency on Technical Regulating and Metrology, Federal customs service, Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing (Rospotrebnadzor), the Ministry of internal Affairs of the Russian Federation. External institutional environment represents, hereby, the diversity of the decisions of the listed institutions affecting the economic entities from outside, which is a product of the functioning of the economy as a whole, including the trade industry [1, 4, 14].

Business entities react to the influence of external institutional norms through adaptation (passive adaptation or evolutionary scenario) and the efforts to change the relevant standards (active adaptation or revolutionary scenario) [8, p. 275].

In addition to external institutional environment the structure of the object of adaptive institutional regulation includes the internal institutional environment. The difference in this context is a set of institutions and norms influencing the trade process. Each of the institutions has a certain number of regulatory processes, the implementation of which allows achieving the corresponding effects in the form of profits, sales or reduced costs as a result of functioning of the entire economic system including a trade enterprise and a trade network [2]. For example, a trade enterprise might be using such set of institutional processes as planning, promotion, financing, budgeting, accounting, etc.

The institution of planning typically includes such kinds of institutional norms and processes as the analysis of the goods turnover, analysis of the circulation costs with varying levels of detail, gross income and margin analysis of the whole enterprise and product groups, analysis of profit and profitability, etc.

Knowledge of peculiarities of an economic entity development and of the life cycle stages of the enterprise lay the groundwork for reviewing inefficient institutions, regrouping the sets of activities in the existing ones and in some cases for introducing new institutions. In this case the

revolutionary scenario of an adaptive institutional regulation of the organization development unfolds. It is the internal institutional environment that is the base of the revolutionary scenario of social and economic development of trade enterprises followed by a significant increase in their efficiency.

In order to define the *adaptive institutional regulation as a process* it is necessary to formulate the *goal* of the adaptation and the way of performing it, thus we can refer to the estimation of efficiency of functioning of a trade enterprise and design the algorithm of its adaptation, determining how to achieve this goal.

The statement that the adaptation as a management action can be viewed as an optimization in the obstructive environment is found in the works of Y.Z. Cipkin: «We will call an adaptation the process of changing the parameters and the structure of the system and possibly the management actions based on the current information aiming to achieve a certain, usually optimal state of the system given the initial uncertainty and constant changing of the environment conditions. ... Essentially we say that adaptation equals the optimization under the condition of insufficient prior information» [15, p. 58]

Generally, the results of business entities activity are measured by the extent their goals are achieved. The goals can express the desired configuration of the system and its separate elements. They might also define a certain trajectory of business development. Besides, for the business entities it is possible to speak about socioeconomic parameters of the implementation of the institutional goals. The question of hierarchical development of the system of adaptation goals can be relevant in this respect. In this case, lower level goals become the means to achieve the higher level ones.

Typically, the goals are considered on strategic, operational and tactical levels [6, p. 23]. Strategic goals are defined in the form of a perfect state, which means that they are formulated but can not be achieved yet. It is preferable to build the hierarchical structure of goals and to design the «tree of goals» before setting the operational goals. Tactical goals offer the means of achieving the operational ones.

It should be noted that the goal of the strategic level can be divided into the operational and tactical goals. The separation of a goal into interrelated components requires one to comply

with principle of the completeness of division. Such division is continued to a degree when in accordance with tactical goals one can identify the exact technology of their implementation in economic, legal, sociological terms and the ways of approaching the relevant norms. Knowledge of these characteristics is necessary for the effective operation of the industry.

Among these types of goals the strategic ones are most critical. These goals define the direction of institutional changes. At the same time the importance of operational goals which are necessary when quickly responding to the changes in institutional regulation tools should not be underestimated. Only the achievement of the operational goals makes tactical and strategic goals possible.

Each of the goals requires its own set of institutional tools. For example, the aggregate tools of achieving strategic and tactical goals, i.e.purchasing power of the population and the money supply in the country, are interconnected and act on the basis of the current institutional tools: interbank interest rate, volumes of mandatory reserves, public offers of government bonds, etc. If the aggregate tools are to change, the current tools need to change as well.

Depending on the specific goals certain adaptive mechanisms or regulating tools can be used.

The selection of tools according to the current institutions and norms has a great importance in the process of evolutionary adaptive institutional regulation of trade development [5, p. 62].

The «right tool for the goal» relation is developed inside the market economy, with its laws and its peculiarities (informal market, grey market, legal market). Therefore, the choice of tools depends on the current economic reality. It is possible to perform the regulation using economic institutional tools and/or social, legal ones, etc [3, p. 27].

In this connection, the quantitative aspect of the relationship of tools and goals must be noted, and «Tinbergen inequality» must be considered. It asserts that the excess in the number of tools over the number of goals allows for optimal system performance. In this light the edge case scenario which still provides the optimal system functioning will be the one where the number of tools is the same as the number of goals [13].

Therefore, it is important to detect the optimal number of institutional adaptation tools that can be used to achieve the goals of effective enterprise development in the trade industry.

The optimal number of institutional adaptation tools can be found using the following model [12, p. 118−125]:

$$y = a_0 + a_1 x + a_2 x^2,$$

where Y represents quantitative parameters of activity of business entities such as revenue, X is the number of institutional tools ensuring the sustainability of the business entities functioning.

Comparing the number of actual institutional tools with the optimal one allows establishing the following balance:

$$Iopt < Ifact;$$
$$Iopt > Ifact;$$
$$Iopt = Ifact,$$

where Iopt is the optimal number of tools of institutional regulation providing a stable functioning of trade enterprises;

Ifact is the actual number of tools of institutional regulation.

The model above can be interpreted as follows. If the actual number of institutional regulators exceeds their optimal quantity it indicates the risk of growing administrative barriers in management. If the actual number of institutional regulation tools is less than optimal, insufficient institutional adaptation occurs.

If the economic practice of business entities shows the inefficiency of current adaptation tools, it forces the management of the enterprise to regroup existing norms/processes within specific regulatory institutions to introduce the new ones or to eliminate some of the existing.

At the same time the rationale of the choice of institutions promoting the sustainability and efficiency of trade entities development is based on the selection of formal and informal institutions. More often than not formal institutions phase out the inefficient informal ones and impede deviant behavior in business relations. Exercising institutional adaptation in the form of institutional agreements increases the stability of enterprise in the trade industry.

Types of adaptive regulators in use, in our opinion, are influenced by the regulator tools.

Institutional regulations based on the feedback loop can lead the system to chaos, prosperity or stagnation depending on a level of their adaptation to the goal of sustainable development of the object.

Among other things, the function of a feedback loop can be illustrated by the kickback on trade contracts. The mechanism of the feedback existing between the processes of informal adaptive

regulation indicated by the size of the kickback can be represented by the following parameters: coefficient of variation, variance and the average value of the kickbacks at the input and the output of the system.

Based on the analysis of the feedback loop one can draw the following dependence: if the deviations of kickback values from the average ones are large enough and the values of the coefficients of variation are significant, the system is close to the critical state and there is the need to introduce various methods of informal and formal regulation. If the values of the coefficients of variation are not excessively large, then the state of the system can be described as balanced.

In general view, the scheme of operation of the adaptative regulatory feedback can be described by such types of the feedback as reinforcing, proactive and balancing feedback.

A special institutional regulatory toolset allowing for the adaptation of the system to the environment is necessary for the achievement of the balanced state of efficiently functioning trade industry. Adaptation should be managed so as to exclude a risk of running unnecessary regulatory quasi-institutions.

Developing the algorithm of proactive feedback involves making prognoses for different possibilities of system development and selecting the most favorable one. The most promising method of projecting proactive feedback in trade industry is adaptive rational modeling. Therefore, proactive feedback allows to build the adaptation mechanism of using tools of formal and informal regulation.

The complex outline of the institutional relations of a business entity suggests a certain algorithm of institutional adaptation:

− formulating the goal of institutional regulation;
− assessing institutional status of the business entity;
− selecting and justifying the regulation tools ensuring both passive and active adaptation;
− designing the adaptation regulatory feedback;
− defining the institutional trade policy of the enterprise taking into account the conducted research.

The diversity of social and economic norms in the trade industry can be illustrated by comparing norms of specific trade enterprises with typical categories of socioeconomic norms of Saint-Petersburg business entities. This means that the assessment of institutional status can imply not only comparing factual and planned norms but also weighing them against the city averages or against industry best practices [10, p. 28].

In addition to the comparisons described above, the institutional status assessment includes a broad spectrum of analytical procedures involving various business activities, evaluation of financial stability of the enterprise and evaluation of its effectiveness. Evidently, an effective industry development requires the alignment of institutional status assessment with productivity indicators of business entities.

One of the possible schemes of institutional status assessment is described in Fig. 1. It comprises various aspects of social and economic development of trade enterprises.

In the developing market in Russia there is no singular typology of institutional behavior of trade enterprises. Most institutional strategies are the results of combination of different types. Growing international relations increased the transparency levels, but did not lead to full institutional adaptation to the domestic and global business environment.

Institutional changes assessment − analysis of dynamics of business norms			
Defining trade enterprises as research objects (subject of norms)	Description of social norms in trade industry	Description of economic norms in trade industry	Revealing additional social and economic institutions and structural changes inside the norm
	Norms evaluation: defining limits of adherence, describing the sanctions for deviant behavior		

↓	↓
Objective factors	Arbitrary factors

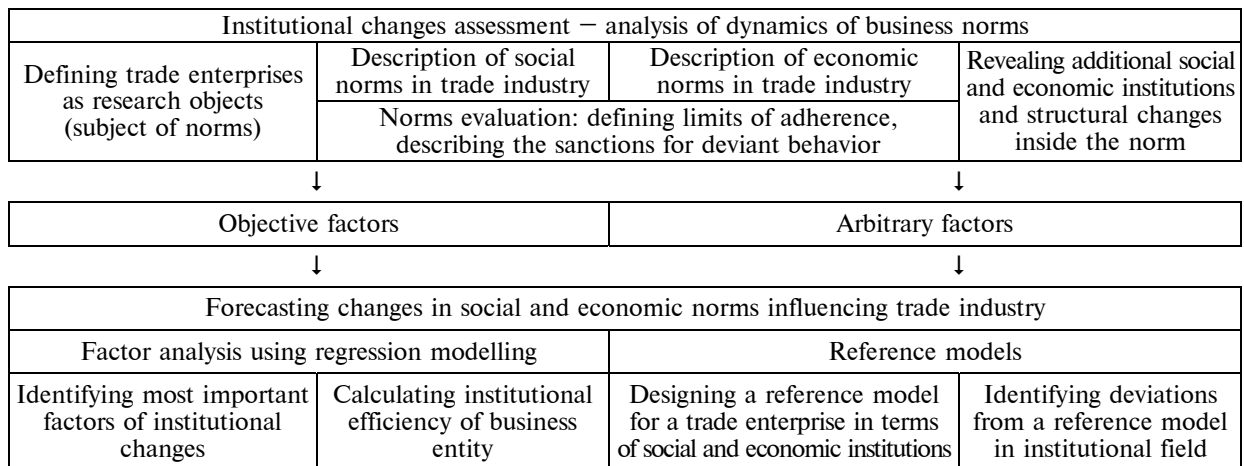| Forecasting changes in social and economic norms influencing trade industry			
Factor analysis using regression modelling		Reference models	
Identifying most important factors of institutional changes	Calculating institutional efficiency of business entity	Designing a reference model for a trade enterprise in terms of social and economic institutions	Identifying deviations from a reference model in institutional field

Fig. 1. Institutional status assessment algorithm (trade industry)

The starting point of the algorithm of institutional status assessment is the development of the institutional trade policy which will set the outline of organizations' institutional strategy. The institutional strategy of the business entity arises from the corporate values and goals, which explain the differences in the adaptation behavior of organizations [7, p. 92]. Some business entities aim at fulfilling 100 % of existing norms and standards, both internal and external. Official paychecks are accompanied by pensions and social benefits for employees. Another group of business entities represents the so-called «opportunists», the ones trying to bend the rules and evade their obligations to the employees or the state. Such enterprises are a priori part of the «shadow» economy. Moreover, main goals of such enterprises include maximizing the profits and minimizing the social responsibility.

At the same time, there is another type of organizations, so-called «constructivists», which are against excessive personnel layoffs in case of high unemployment rates in the region, and form lobbyist relationships with the government, invest in socially important projects in return for tax cuts, etc. Business entities of another type use an alternative, neutral institutional strategy. These enterprises do not rely on government's help and build their relationships with business partners based solely on economical reasons. Personnel relations (wages, benefits, layoffs) are also calculated basing on profitability.

The prediction of future institutional status of an enterprise implies taking into account the factors affecting the change of norms and processes in trade organizations. First of all, it is connected to the development of business relations inside the enterprise, aiming to increase the productivity of the trade system as a whole. The number and the specifics of factors affecting the phases of life cycle are individual for each organization. The higher is the accuracy of quantitative evaluation of the influence of these factors, the higher is the efficiency of institutional transformation.

The arbitrary factor examples are the following: the use of specific incentives for employees and the use of specific controlling models and corresponding executive decisions in the organizational structure. Taking into the arbitrary factors account increases the possibility of achieving the desirable level of efficiency.

Also, the importance of accounting for the objective factors should not be underestimated. For example, growth of average citizen's income through the increased demand affects positively the levels of commodity circulation, pricing decisions and, therefore, the efficiency of business entities in the region.

Consequently, the quantitative prognosis of changes in institutional status of a trade enterprise requires accounting for the multitude of factors, both short-term and long-term, affecting the development of the industry subjects.

Study results

1. The definition of institutional regulation of socioeconomic development of a trade enterprise was clarified, factors affecting it were described, and mechanisms and tools of institutional adaptation were determined.

2. The algorithm of institutional status assessment was introduced, which is one of the stages in setting up the system of institutional adaptation of trade enterprises allowing us to point out the deviation from reference values in institutional outline.

Conclusion. This study justifies the necessity of institutional adaptation management using institutional status assessment in trade enterprises.

Directions for further studies. The development of the program of institutional adaptation as a key element of institutional trade policy of trade enterprise.

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DEVELOPIING A REFERENCE MODEL
OF THE INFORMATION SYSTEM ARCHITECTURE
OF HIGH-TECH ENTERPRISES

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РАЗРАБОТКА РЕФЕРЕНТНОЙ МОДЕЛИ АРХИТЕКТУРЫ
ИНФОРМАЦИОННОЙ СИСТЕМЫ
НАУКОЕМКИХ ПРЕДПРИЯТИЙ

One of the main problems in high-tech enterprise management is the issue of integrated logistics support of production and service, which is not considered an independent methodological problem by manufacturers. The article describes the baseline architecture of the information system based on the CALS conceptual model (Continuous Acquisition and Lifecycle Support). Research into ILS tasks and reference architecture components made it possible to propose a reference architecture model of the unified ERP II system for integrated logistic support. Two main approaches to developing integrated systems were considered while constructing the information system architecture: mono platform and poly platform. Poly platform systems integration is used as a method of constructing the target architecture of a unified information system for information support life cycle product (with all the necessary improvements). A gap-analysis of the transition from the baseline to the target architecture, reflecting the main stages, is provided. The proposed reference architecture model of an information system represents a possible solution that provides support for solving not only the integrated logistics support problems but also the core tasks of the enterprise: supply chain management, resource planning, customer and supplier relationship management. A reference model of the system architecture was built with due regard to integration tools for information exchange in a single information space between all the subsystems. The proposed model is based on a single service-oriented platform and the Integration Bus which allows connecting systems of different manufacturers. Each system is discussed in detail. The key functions and tasks of each system (general and service ones) are described.

INTEGRATED LOGISTIC SUPPORT; CONTINUOUS ACQUISITION AND LIFE CYCLE SUPPORT; REFERENCE MODEL; INFORMATION SYSTEM; TARGET ARCHITECTURE.

Одной из основных проблем в управлении наукоемкими предприятиями является проблема интегрированной логистической поддержки производства и сервиса, которую производители не рассматривают как самостоятельную методологическую. В статье приводится описание базовой архитектуры информационной системы на основе концептуальной модели ИПИ (информационная поддержка жизненного цикла изделия). В результате исследования задач интегрированной логистической поддержки производства и компонентов базовой архитектуры предложена референтная модель архитектуры единой информационной системы класса ERP II. При построении архитектуры информационной системы рассмотрены основные подходы к формированию интегрированных систем − моноплатформенный и полиплатформенный. В качестве метода построения целевой архитектуры единой информационной системы непрерывной информационной поддержки жизненного цикла изделия использована интеграция (с необходимой доработкой) полиплатформенных систем. Приведен gap-анализ перехода от базовой к целевой архитектуре, отражающий основные этапы. Предложенная референтная модель архитектуры информационной системы является одним из возможных решений, обеспечивающих поддержку решения задач как интегрированной логистической поддержки производства и сервиса, так и общих задач производственного предприятия: управления цепочками поставок, планирования ресурсов, управления взаимоотношениями с клиентами и поставщиками. Построение референтной модели архитектуры системы выполнено с учетом инструментов интеграции обмена информацией в едином пространстве между всеми подсистемами. В основе предлагаемой модели лежит единая сервис-ориентированная платформа и интеграционная шина, позволяющая «бесшовно» соединять системы разных производителей. Каждая система подробно рассмотрена, описаны ее ключевые функции и решаемые задачи (общие и относящиеся к сервисному обслуживанию).

ИНТЕГРИРОВАННАЯ ЛОГИСТИЧЕСКАЯ ПОДДЕРЖКА; ИНФОРМАЦИОННАЯ ПОДДЕРЖКА ЖИЗНЕННОГО ЦИКЛА ИЗДЕЛИЯ; РЕФЕРЕНТНАЯ МОДЕЛЬ; ИНФОРМАЦИОННАЯ СИСТЕМА; ЦЕЛЕВАЯ АРХИТЕКТУРА.

Manufacturers of sophisticated scientific products are in continuous search for new ways and approaches to cement their positions in the market and to increase their marketability [1, 2]. The CALS (Continuous Acquisition and Lifecycle Support) concept is applied to provide coordinated work of all companies engaged in designing, manufacturing, distribution and operating scientific products. At the same time, no due attention is paid to the ILS industrial problem (Integrated Logistic Support). Existing foreign solutions need serious adaptation to the domestic manufacturing of sophisticated scientific products in regard to both regulatory documents and the application of information technologies to support ILS processes within the framework of an integrated information environment (IIE) [3]. In the course of IT support of ILS problem solution, most of the focus is on an PLM (Product Lifecycle Management) system which manages a product life. And every enterprise develops its own individual approach ([4−7]). It is, however, expensive, inefficient, slow, and rarely reaches expected results. IT support of ILS cannot be a system task to be assigned and solved.

This article suggests a reference architectural model of the uniform information ERP II system for integrated logistic support which helps to avoid the abovementioned shortcomings and to develop and introduce necessary architectural decisions. Such a system aims to shorten resources for scientific product preproduction and manufacturing, to improve the quality of manufacture and post-sale support of products due to the introduction of an integrated automated system based on a single digital space.

According to a systematic approach to enterprise management, the components of an enterprise architecture must be formed, reformed and developed according to their interdependency [8]. One of the most dynamic and demanded segments of information systems in production of high value-added products that requires ILS systems for effective service is information systems supporting the product life cycle which are based on integrated automated information systems [9−10]. At the same time, costs of sophisticated product maintenance exceed purchase costs [11]. Reducing product life cycle costs is one of the goals to be achieved by the introduction of the CALS concept and strategy.

Fig. 1 shows the basic architecture of the information environment of scientific companies according to the CALS conceptual model [11].

IIE forms the basis for CALS. All IIE data are stored as information objects to which a uniform system of guidelines concerning information representation, storage and interchange applies [12]. IIE information processes support the product at all its life stages.

The basic architecture includes five key inter-integrated blocks which constitute the uniform information space of a company.

Such an architecture based on the CALS conceptual model mirrors its invariant concepts which can be divided into two groups [11]: the key CALS principles and the basic CALS technologies. The latter ones are implemented by multifunctional working groups comprising experts from different fields [11]. The regulatory framework for developments consists of international and national standards [13−15] regulating various aspects of CALS technologies.
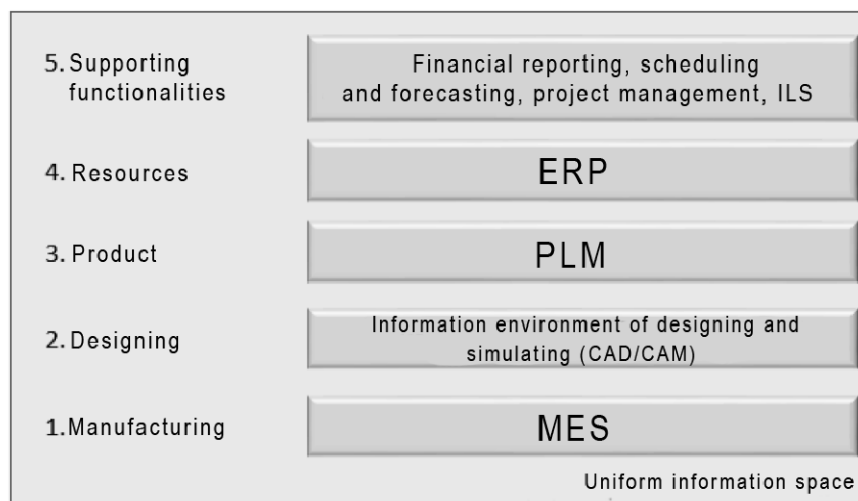

Fig. 1. Basic architecture

A complex mix of administrative processes and procedures to reduce costs at the post-production stages of the product life cycle (sometimes referred to as 'ownership costs' [16]) are united by the concept of ILS. This is one of the CALS basis invariant concepts. No information system can be associated with CALS until an ILS component is implemented in it to a certain extent. On the other hand, the process content and ILS problem composition are essentially independent of the subject area.

The analysis of normative documents ([17–21]) helped to identify the main problem related to integrated logistic support and to formulate primary tasks aimed to solve it. The ILS of a sophisticated scientific product involves the implementation of four basic processes [11]:

− product LSA (Logistic Support Analysis) at all stages of the product life cycle;

− product MRP (Maintenance and Repair Planning);

− product ISSPP (Integrated Supply Support Procedures Planning) at the design stage, later detailed in the course of the manufacturing and use of the product;

− providing personnel with Electronic Maintenance Documentation (EMD) and Electronic Repair Documentation (ERD) for the product at the design stage and in the course of manufacturing particular copies (sets) of the product.

The combined impact of the introduction of CALS technologies depends largely on the level of the integration of business processes and automated subsystems supporting them. The consolidated positive effect of employing information systems at every stage of the product life cycle can be reached by integrating business processes [22–23] applications and data within the product uniform information space.

In such a way, an integrated system of life information support for high value-added products must cover the following interacting basic components:

− exchange of information with the design departments that develop product Engineering Documentation (ED) at the level of data and processes (accepting, transferring, updating electronic ED);

− centralized / single pre-production engineering;

− management of the designing, manufacturing and application of hardware;

− pre-production engineering in assembling shops;

− management of product assembly processes with the prevalence of manual operations (including interaction with copartners, raw material and equipment suppliers);

− monitoring of the design, engineering, manufacturing processes and product operation;

− performing logistic analysis (calculating ILS efficiency indices, ILS designing, determining resource requirements, etc.);

− support of problem solving at every level of product Material and Technical Support (MTS) and product Maintenance and Servicing (MS) (schedule control, the calculation of the optimum amount of spares in store, repair team management, MS events planning, etc.);

− support of tasks for effective and integrated with the above tasks functioning of the supply chain.

When developing a reference model, it is necessary to consider that the information system must provide solutions to the following tasks:

1) in regard to logistic and financial analysis:

− strategy development, planning and control of the logistic analysis process;

− strategy development, scenario simulation of the product life cycle from a cost perspective in different currencies;

− design analysis of the product at its developing stage to formulate recommendations for the provision/improvement of reliability, maintainability, technical readiness, operational processability, and the supportability index;

− development and analysis of product Technical Maintenance System (TMS) variants to provide specified requirements related to the product life cycle, readiness and supportability;

− analysis of interaction of the product and TMS to determine the combination to ensure its supportability requirements;

− control of the product supportability index during its use and the determination of factors having a negative influence on this index;

2) in regard to maintenance and repair:

− provision of the specified level of the product readiness during its use;

− management of the maintenance and repair of sophisticated products with an allowance for their actual condition;

− maintenance and repair works period, composition and content control;

− provision of operation and resource planning for the maintenance of the whole product and its parts;

− control over work completion for all kinds of maintenance;

− requesting all services for the whole product and its parts;

− getting reference information on the period, composition, duration and intensity of works, on the performer, and necessary spares, materials, and equipment for all services;

3) in regard to operation management:

− monitoring of the technical condition and operational readiness of the equipment;

− storing of information on all the equipment in use: its structure, technical data, warranty and service contracts, operational documentation;

− maintenance and repair works scheduling, schedule and results recording;

− stepped equipment maintenance and repair manuals;

− maintaining inventory of spare parts, consumables, and other materials necessary for equipment operation;

− planning and control of material purchases for equipment operation;

− electronic equipment logging;

− circulation of electronic documents accompanying the product's use;

− taking account of the level of expertise and availability of service personnel;

4) in the development and application of Interactive Electronic Technical Manuals (IETM):

− providing users with reference material on the product design and functions;

− training personnel to perform in conformity with operating, servicing and repairing regulations;

− providing users with reference material necessary for the product operation, maintenance and repair;

− providing users with information on the product operational techniques, on necessary tools and materials, on personnel quantity and qualification;

− equipment diagnostics and troubleshooting;

− preparation and filling of automated materials and parts orders;

− maintenance scheduling and reporting;

− consumer/supplier data exchange.

Let us specify the scenario of the continuous information support of the product life cycle. There are two known approaches to forming the uniform information space of the product life: applying a set of automated systems (CAD, PDM, ERP, CAPP, MES) by the same maker (mono-platform solution); integrating subsystems by different makers (poly-platform solution) [24]. Choosing one or the other approach depends on a series of parameters: economic and time indices, operational/technological indices, indices of functionality, production process compliance, business process compliance.

Another possible scenario of establishing the continuous information support system of the product life cycle can involve integration (including necessary improvements) of poly-platform systems [12]. A mandatory requirement is the compliance of integration tools and the system as a whole with automated system requirements according to regulatory and production documents. The practicability of developing an integrated poly-platform system for the information support of the product life cycle of the high value-added product can be specified by the following factors:

− high cost and a long period of adapting foreign systems to the domestic specificity;

− availability of know-how in the field of integrating information systems and data in automated control systems;

− availability automated subsystems tailored to domestic manufacturing processes;

− availability of know-how in the world and domestic practice of business process integration, applications and data.

In view of the above, it is a model of the poly-platform integrated system of the continuous information support of the product life cycle that was chosen to develop a reference model of the information system for integrated service support.

A management information system provided the basis for the interaction of the structural components of the ILS system. Its key rule is that the information occurring at any stage of the product life cycle is stored and becomes available for all participants in accordance with their rights (levels) to information access. Fig. 2 shows the structure chart of a management information system.

The diagram shows both the manufacturer of sophisticated scientific products and the consumer. The manufacturer has the product regulatory and reference information obtained during the development, manufacturing and complex logistic analysis of the product. The consumer is provided with interactive electronic technical manuals and product reference data in electronic form. Also, the consumer makes and transfers scenarios of the product's use, provides electronic data exchange between their service and MTS systems and the manufacturer`s management information system.
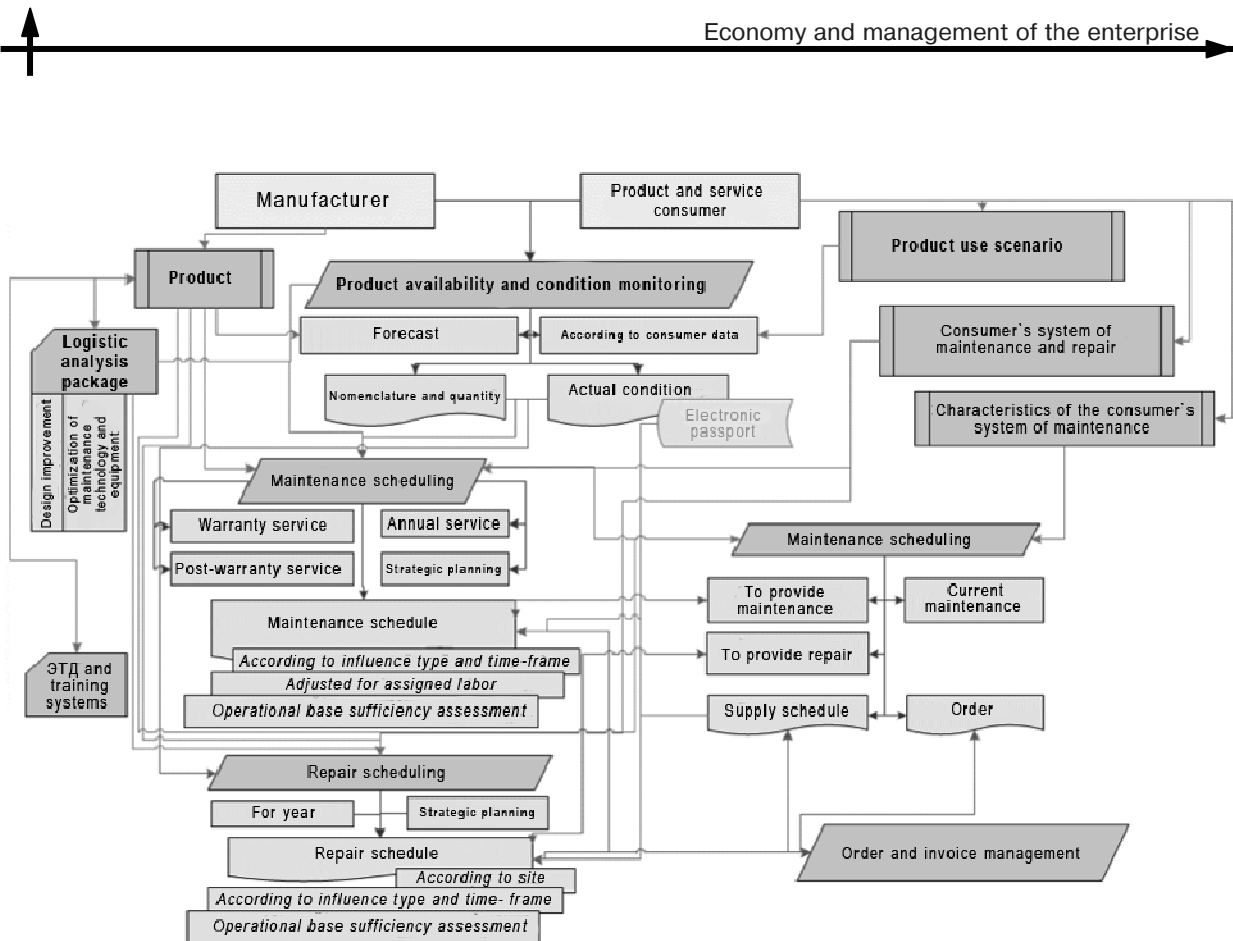
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Fig. 2. Management information system

During the product's use, its operation profile is monitored by both the manufacturer (forecast data) and the consumer (actual data). These data are consolidated in the management information system and are instrumental in creating the product's electronic passport. Also, information on the current condition of the product is used by the manufacturer to adjust and to perform maintenance as well as to organize the MTS schedule to support MS events.

The scheduling of maintenance events and just-in-time purchasing of spare parts are done on the basis of MTS and ISSPP plans which consolidate actual and forecast data of the product use. The integration of automated Enterprise Resource Planning and Material Requirements Planning (ERP/MRP) information systems and systems of service management (supply, service, repair, utilization, information support, etc.) provides the pass-through optimization of material flows and resources at all stages of the product life cycle.

In response to ILS challenges and the above diagram, we propose the following reference model (target architecture) of an ILS information system (Fig. 3).

The complex of the systems presented in Fig. 3 suggests a uniform integration platform implementing the strategy of the uniform integrated system that combines technology and software.

The uniform platform allows applying the single sign-on technology which providies the user with the possibility to leave one system and enter another without reauthentication. The single sign-on technology makes it possible to reduce time spent re-entering passwords for the same account and to cut IT service costs due to a decrease in password reset requests.

An integral part of the uniform platform is the integration bus which provides an integration universal interface to systems on the integration platform if, for example, these systems are issued by different manufacturers (Oracle, SAP, 1C, Siemens, etc.). The core of the integration bus is the Integration Engine that performs typical functions of the message broker, including message conversion, routing, publication and subscription tools. The most important advantages of the integration bus are:
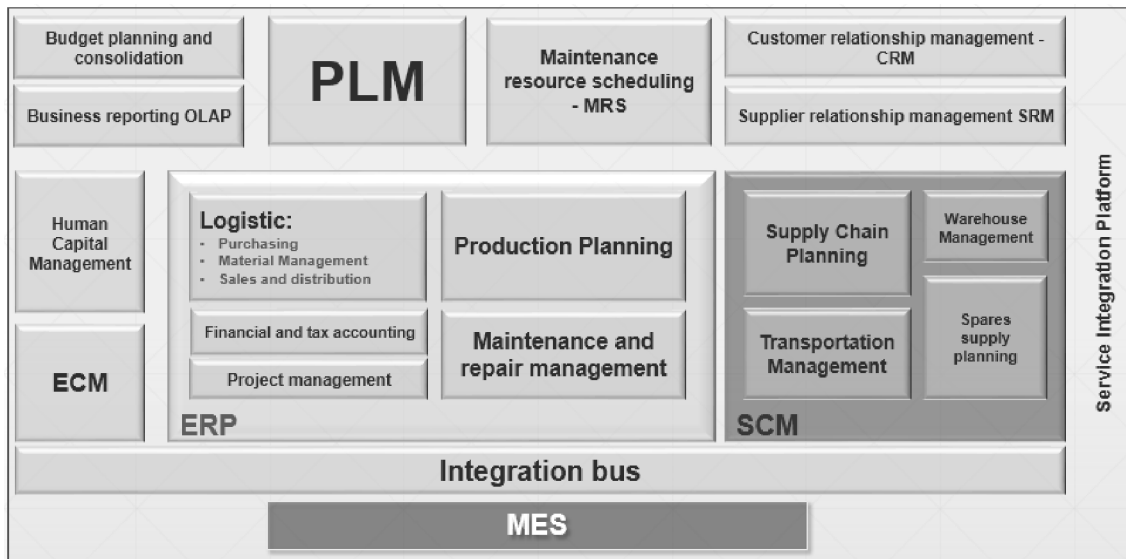− flexible integration of the company's IT landscape;

Fig. 3. Reference model (target architecture) of the integrated ILS system
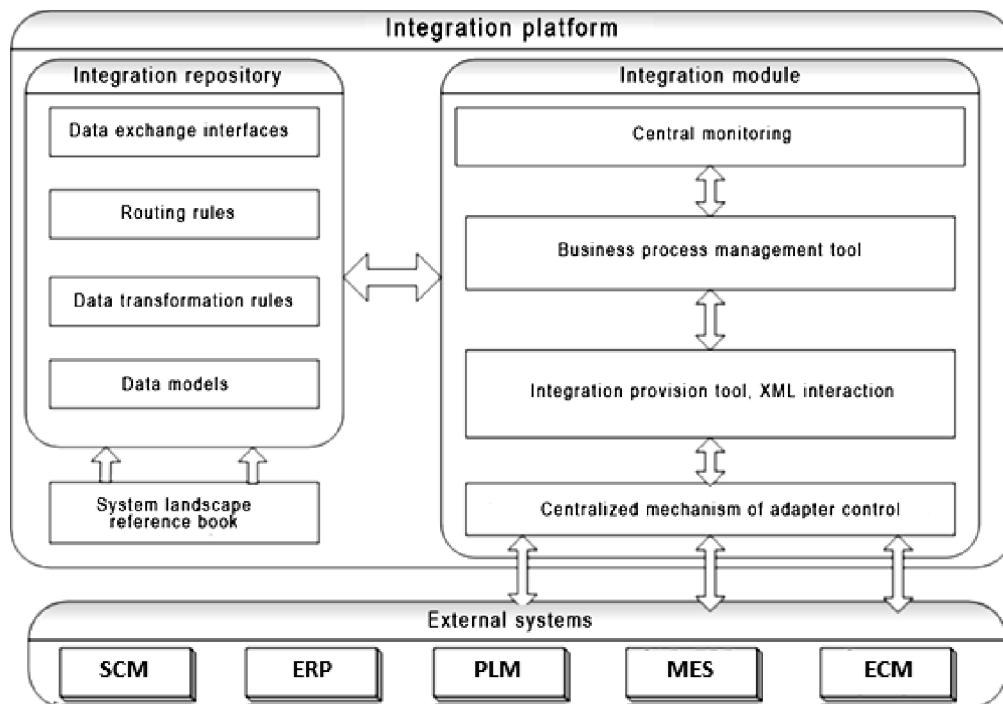

Fig. 4. Integration bus architecture

− reduction of costs associated with the introduction of new systems as a result of keeping contributions to existing systems;

− a single center of information on systems, components and intercomponent processes of the enterprise;

− centralized monitoring of intersystem processes.

The following integration principles should be applied to create an information bus architecture [25−26]: a single access point for information exchange of all systems, all interfaces of data exchange are based on the same integration platform, seamless integration, a uniform interface model (all interaction interfaces are in XML format).

The integration bus architecture shown in Fig. 4 consists of three blocks:

1) integration repository with a description of data exchange interfaces, with routing rules, data models, and their transformation;

2) integration module that performs central monitoring of data exchange and provides integration and XML interaction;

3) the third block refers to the examples of the systems involved in data exchange.

Systems to be integrated within the proposed architecture of the ILS system (Fig. 3) are divided into 4 blocks: MES (Manufacturing Execution System), ERP (Enterprise Resource Planning), SCM (Supply Chain Management), auxiliary systems beyond ERP functions.

A MES system supporting production process must be included in the uniform integrated environment, as it is one of the key suppliers of raw information about the product. MES system information is primarily used by an ERP system to solve, for example, tasks of logistic analysis, MS planning, MTS planning and support, accounting and taxation, enterprise key asset management, etc. In the proposed architecture, the ERP system mainly performs accounting and administrative functions.

Logistics control is an individual SCM system that comprises the following modules:
− warehouse logistics management;
− transport logistics management;
− supply planning;
− logistics chain planning;
− uniform information portal for all the participants of the supplying process.

The salient feature of the implementation of an SCM system within the envisioned general architecture of the ILS system is its orientation to product maintenance. Such a system aims to support service operations of sophisticated technical products, namely Service Chain Management. To ensure efficient service, an SCM system must meet the four key challenges:
− minimization of client waiting time;

Fig. 5. Place of SCM in the system architecture

− minimization of resource idling;
− maximization of personnel efficiency and other resources;
− maximization of client satisfaction.

According to the above problems, it is possible to specify the place occupied by SCM in the IIE architecture (Fig. 5). SCM closes gaps in the functionality of the given systems, ensuring their combination in the ILS context. Human resource management systems are also stipulated in the IIS architecture.

The human resource management system in the proposed architecture provides a solution of general problems of HR management: working time recording, HR recordkeeping, HR administrating, organizational structure management, payroll accounting, etc. In order to solve ILS problems, an HCM system should be integrated with an MRS system (resource planning) which provides an extension of the basic functional to cover specific ILS problems.

The MRS (Multi Resource Scheduling) system meets the key business requirements and aids to increase the enterprise's profitability by optimizing the processes of HR planning intended for rendering service in service centers and for performance on site.

The integrated information system architecture also includes a system of customer relationship management (CRM). The current process of decision making, purchasing and operation of a scientific product in the B2B market can be conditionally divided into the following stages:

1. Customer's realizing and stating the problem that the product can help to solve.

2. Generating different solutions to the problem, including ones that imply using the product. Comparative analysis and the choice of the basic variant related to the product purchase and its specific technical implementation.

3. Analysis of different ways the product can be purchased (according to the financial, logistical, geographical and other features of the business). Choosing and purchasing the optimum alternative.

4. The product's delivery, presale preparation, commissioning, incorporation into the existing technological system, test operation.

5. Working operation, maintenance and reconditioning repair of the product during its lifetime.

6. The product improvement and modernization.
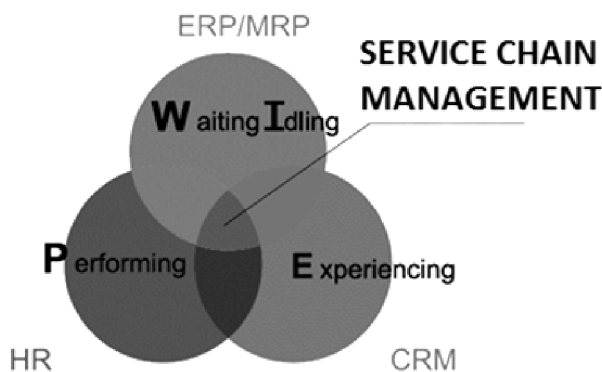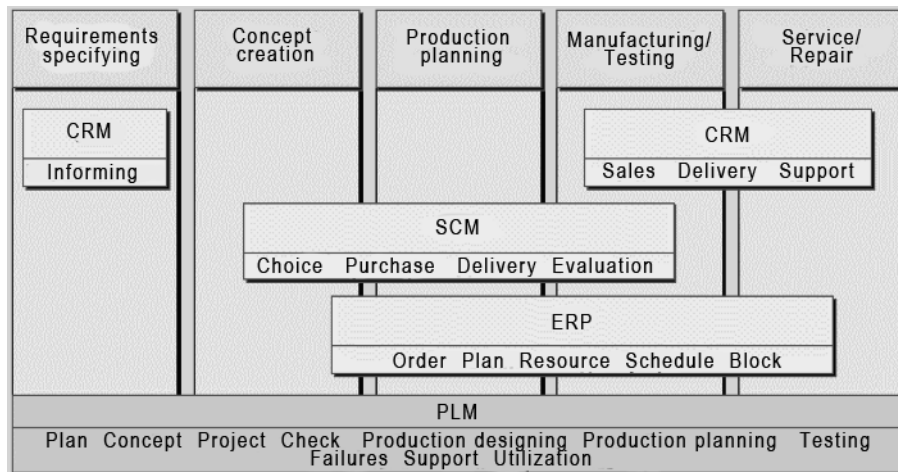
7. The product utilization.

Fig. 6. Place of PLM in the uniform information environment of the enterprise

Strong and well-established relations with suppliers are essential for good maintenance service. To that end, the IIE architecture stipulates a Supplier Relationship Management (SRM) system which can work in integration with any solutions of Supply Chain Management (SCM), Product Life Management (PLM) or Enterprise Resource Planning (ERP) with no regard for the suppliers of the given systems. This can be achieved through the integration bus which incorporates the system into the common integration platform.

Operating business processes of designing, manufacturing and integrated servicing of a sophisticated scientific product in a clearly defined and mutually supportive way is impossible without a system that allows storing and managing data related to a product throughout its life cycle in a centralized manner. For this purpose, the architecture stipulates a system supporting a Product Lifecycle Management [27] strategy. A PLM system coordinates the enterprise activities, connects CRM and SCM systems, provides management of the life cycle of the product at all stages of its lifetime, from the moment of its conception till its utilization (Fig. 6).

The suggested IIE architecture model also includes a BI class system to generate and present analytical business reports that employs OLAP data processing technology.

An important stage in developing a reference model of scientific enterprise architecture is gap analysis that is instrumental in specifying the key steps and necessary changes in the target architecture. This stage discovers mismatches and consolidates business requirements, technological needs, data and application requirements.

That is obviously impossible to instantaneously replace the base architecture with the target one.

This is because a simultaneous launch of all the enterprise systems in the target architecture into productive operation can involve the following risks:

− integrated information system cannot operate for technical reasons (server capacity, connection stability);

− integrated information system cannot operate for organization reasons (a level of consumer competence, significant changes in work with counteragents);

− significant extension of IIE commissioning periods due to prolonged testing (functional, integration) and training stages.

To shift to the target architecture, it is necessary to overcome the following gaps among functional structure components:

− SCM logistics;
  • organizing supply chains;
  • warehouse logistics;
  • shipping logistics;
− centralized product data management;
− management of relationships with counterparts;
  • with suppliers;
  • with customers;
− comprehensive enterprise resource planning;
− HR management;
− Electronic Document Circulation (EDC) system;
− business reporting;
− budgeting and consolidation.

In connection with this we suggest staging transition from the basic architecture to the target one.

At the first stage, it is reasonable to move from Product Data Management (PDM) to a Product Lifecycle Management (PLM) strategy which aims at more efficient support for the complete

life cycle of the product by providing team developments throughout the whole product lifetime in partner networks, technologies of product development support and production process improvement as well as innovation approaches at all stages.

The second stage involves activating the SCM block that includes the functionality of supply chain management as well as warehouse and shipping logistics management. The execution of this stage allows arranging the basic logistic processes of the enterprise as a whole and in the sphere of the logistic support of maintenance service.

The third stage solves problems of information support of CRM and SRM systems, performs the migration of relevant key data (debtor and creditor basic records, etc.) from an ERP system by means of integration bus tools. The planning module is considered as an individual system (replenishment planning, scheduling for repair teams, service parts planning, transportation planning). Basic data for planning enter the system through the integration bus.

At the fourth stage, it is expedient to unfold a budgeting and consolidation system, including business reporting, because a significant extension of the composition of co-functioning information systems implies the availability of real data volume which can be a reporting base. The commissioning of a reporting system at this stage makes it possibly to accurately calculate volumes of data samples and estimate the required technical capabilities of hardware.

The final stage involves launching such auxiliary systems as HR centralized management and electronic document circulation. This allows embracing all forms and documents used by the enterprise and catering for the specifics of paperwork and sharing documents with counterparts. The introduction of an HR management system at this stage helps to reach all positions and recruitment needs, to ensure their effective planning, factoring in the business processes which were already established on the created system landscape.

The proposed reference model of information system architecture provides support for the solution to both ILS problems and general problems of a production enterprise. Also, this model represents the only way to provide integration of key systems and technologies used throughout the product life cycle and to establish control over product development and fixed asset management. The suggested information system architecture is based on a uniform service platform and an integration bus for a seamless connection of different systems. The reference system architecture model is designed with provisions made for information exchange integration tools in the uniform space among all the subsystems. The outlines of applied research on the discussed issues were reflected in the GOSTs of ILS in Russia as well as in foreign ISO standards. The subject is sure to be developed further due to the economic benefits associated with the implementation of the reference architecture model.

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AN ITERATIVE PROCEDURE OF CONSUMER RESEARCH IN A NARROW MARKET SEGMENT

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ОБ ОДНОЙ ИТЕРАЦИОННОЙ ПРОЦЕДУРЕ ИССЛЕДОВАНИЯ ПОТРЕБИТЕЛЬСКОГО СПРОСА НА УЗКОМ РЫНОЧНОМ СЕГМЕНТЕ

The article analyzes the conditions, peculiarities and application techniques of the step-by-step method of iteration to the equations simple regression which are not reduced to any linear forms of their own parameters and variables. Such a practical task arises often enough during the investigation of the class of Tornquist functions. In practice, such tasks arise in economics during research and analysis of consumer demand on a narrow market segment. In particular, the 2nd equation of this class successfully describes a Russian family's cost for the purchase of relatively expensive tourist products for foreign travels. The method of progressive approximation regards the plotting of the normal equations set with application of the Jordan−Gauß process and the expansion into Taylor's infinite series of the function of the corrections for parameters of the desired equation. The amendments themselves are allowing to calculate the parameters of the Tornquist functions (2nd equation) and accomplish the forecast estimations of budget charges for purchase of the expensive tourist's products. The considerations expressed in this article lead to three local outputs on the applicability of the procedure in question in dealing with similar ones on the content of economic and statistical research problems of supply and demand a high level of tourist products: in the epistemological and methodological aspects of the formulated problem of estimating the parameters in a typical nonlinear this technique (sequential iterative procedure) does not give a final decision, i. e. the results are not complete and not statistically pure; because of the inherent rounding even reliable and accurate measures of economic parameters are approximate. When using iterative procedures, approximation error is added to the actual implementation of the method, and its effectiveness depends on the more or less successful choice of initial conditions approximation and the convergence rate of the iteration process; finally, a common approach to stochastic approximation of a nonlinear function is understood by the author through the use of Taylor series and polynomials search for suitable forms. In particular, the linearization of the equations of simple regression with typical nonlinearity must be carried out by the power series expansion with all members of the first order of smallness eliminated from further calculations.

APPROXIMATION APPROACH; LINEAR FORM; REGRESSION EQUATION; PROBABILISTIC DISTRIBUTION; TOURIST'S PRODUCT; SEGMENT OF THE MARKET; CONSUMER DEMAND.

Статья посвящена анализу условий, особенностям и техникам применения метода последовательного приближения к уравнениям простой регрессии, которые не сводятся к каким-либо линейным формам в отношении собственных параметров и переменных. Такая практическая задача возникает достаточно часто при исследовании класса функций Торнквиста. Как показывает практика, такие задачи возникают в экономике при исследовании и анализе потребительского спроса на узком рыночном сегменте. В частности, второе уравнение этого класса удачно описывает расходы российских семей на приобретение сравнительно дорогих туристских продуктов для зарубежных путешествий. Итерационная процедура предусматривает построение системы нормальных уравнений с использованием способа Жордана−Гаусса и разложение в бесконечный ряд Тейлора функции поправок к параметрам искомого уравнения. Сами поправки позволяют рассчитать параметры функции Торнквиста (второе уравнение) и сделать по ним прогнозные оценки бюджетных расходов семей на дорогие турпродукты. Представленные результаты в части применимости рассматриваемой процедуры для исследования спроса и предложения на примере дорогих туристических продуктов позволяют сделать ряд выводов: для сформулированной проблемы методологических

аспектов оценки параметров в типичном нелинейном формате последовательная повторяющаяся процедура не дает окончательного решения; из-за округления даже при использовании надежных исходных данных получаемые оценки экономических параметров приблизительны. Когда использование повторяющейся ошибки приближения процедур добавлено к фактической реализации метода, эффективность зависит от успешного выбора начального приближения условий и темпа сходимости итеративного процесса; общий подход к стохастическому приближению нелинейной функции использован автором с помощью ряда Тейлора и поиска полиномов подходящих форм.

ПОСЛЕДОВАТЕЛЬНОЕ ПРИБЛИЖЕНИЕ; ЛИНЕЙНАЯ ФОРМА; УРАВНЕНИЕ РЕГРЕССИИ; ВЕРОЯТНОСТНОЕ РАСПРЕДЕЛЕНИЕ; СИСТЕМА НОРМАЛЬНЫХ УРАВНЕНИЙ; СЕГМЕНТ РЫНКА; ПОТРЕБИТЕЛЬСКИЙ СПРОС.

Introduction. A sample produced according to the rules of statistical observation of the population of socio-economic nature is not, ultimately, necessarily representative. Even after the homogenization procedure, sample homogeneity of private units together may be questionable. For the same correlation values, the essential features of these sampling units can have a quasi-random character. If, moreover, even regression, based on such dubious information database designed to describe and identify patterns (pre-theoretical basis), expressed by a nonlinear equation can not be reduced to a linear form, then, an analyst tends to group separate issues to be detailed solutions. Some of the problems identified are addressed in this article.

The previously widespread orthodox (in the best semantic sense of the term, i. e., consistently and rigorously adhering to any existing views and eminent statisticians) viewpoint that the units (elements) of public and private statistical universe must have «... really good, uniform type of a general Bernoulli population, with which we have to deal in a particular activity ...» [1.20; 9], has recently been drawing increased serious but not always justified criticism.

For example, such critical constructions assumed that modern statistical science (!? − *A.B.&A.Ts.*) comes from the fact that the specifics of a complex set of features is not exhausted by its homogeneous parts, and is mainly in the structure of the population, and especially the nature of links and the relationship between the parts [2.17−26]. These authors suggest that a systematic approach is needed for a comprehensive study of complex aggregates, including both homogeneous and heterogeneous parts, from the standpoint of system analysis − the same approach that has received a powerful development in various fields of science, including the social and the humanitarian sectors. Heterogeneity of the study population in this case cannot be taken into account and it is not an obstacle to the application of the mathematical apparatus.

Review. However, the solution covers a sufficiently wide range of problems of social and economic nature relating to the statistical analysis of two-dimensional distributions with fixed because the phenomenon is often reduced to the construction of the equations of simple regression, non-linear with respect to its parameters and variables.

Suppose there is a regression equation resultant in the variable of the type

$$y_j^{(i)} = f(\vec{a}_k, x_i) + \varepsilon_i = f(a_o, a_1, ..., a_m, x_i) + \varepsilon_i. \quad (1)$$

In the formula of (1) f − is generally a nonlinear function of the simple regression from one unaccounted causal factor x_i n observations on aggregate, $i = \overline{1, n}$, with a vector $\vec{a}_k$ of unknown parameters $k = \overline{0, m}$; with ε_i, or $\vec{\varepsilon}$ − the random component, it is also a random component, or the residual value, or \residual vector\ and other synonymous concepts found in the statistical literature and describing the discrepancy between empirical and theoretical levels, as well as meeting the following mandatory requirements of the general theory of statistics:

а) $E[\varepsilon_i] = 0$; б) $\text{cov}(\varepsilon_i, \varepsilon_i') = 0$; − ∃,

в) $\text{M}\{\varepsilon_i\} \sim N(0, \sigma_\varepsilon^2)$, (2)

i. e. the vanishing of the expectation (E) of the random component ε_i, the lack of statistical association (covariance − *cov*) and normal (*N*) mathematical distribution set (**M**) of random deviations $\{\varepsilon_i\}$. The sign «~» indicates the fact that the random variable under study is a probabilistic distribution.

Of course, conducting a regression analysis of any dimension is preceded by the presence of statistical association between productive and formative (or forming) features, such as estimates of the relationship between the cost of guided tours of a family and its income. Determination of the probability of the fact that the statistical relationship between the studied traits factor is random is called the *test of statistical significance*. In the course of this evaluation procedure, usually

in the fully functional analytical system package *SPSS*-19.00 *Statistics for Windows*, the value of the selected statistical test is set, along with the number of degrees of freedom, *p*-rate statistics et al.

If the probability measure, i. e. the *p*-criterion, is below table level of 0.05, the relationship variables are recognized as statistically significant; if it is above, then such a connection cannot be considered significant. Naturally, the statistical significance of a possible link between variables depends on the sample size. It follows from a sample from a population of not less than the volume of a large sample, i. e., $n \geq 101$ [3.254].

Estimating the parameters of a simple regression equation (2) can be difficult, which is mainly related to the possibility (or rather impossibility) to linearize the function f with respect to its parameters and variable x_i with the known methods for subsequent evaluation using the *method of least squares* (*OLS*) which is a special case of the method of *maximum likelihood* (MLH developed by K. Gauss, P-C. Laplace and R. Fischer). Therefore, for such cases there is a separate procedure, since the OLS estimation of the parameters of the nonlinear form is unaccesptable, as all kinds of *OLS* estimates are determined based on the constructed system of normal equations.

It is known that the parameters of the regression equations, which are measured by the method of least squares, must be contained in the linear forms with respect to the independent variables and the resultant variable. However, not for all of the equations, both simple and multiple regressions can be kept to a desired linear form. By a similar equation the 2nd equation Tornquist[20] is applied.

Suppose we have information according to budget and sociological surveys of household expenditure on the *j*-th goods and services of a certain quality for the year y_j depending on the per capita income of the *i*-th family − x_i. This initial information grouped by income groups successfully *approximated* the 2nd Tornquist equation belonging to the group of remarkable nonlinear equations.

Approximation (*Approximation approach, method of approximation*) is an independent task belonging to a class of problems that are studied branches of mathematics − approximation theory and numerical analysis techniques. To calculate the values of complex functions, the values of the interval variation series are often calculated by an approximating

function. Thus, the described approximation refers to a table or the mathematical function dependence.

The initial data for a particular purpose is usually a table of observations − a set of values of the independent variables and the corresponding values of the response function. The number of rows (nodes) of a tabulated function $\{n\}$ is called the *volume* of available sample of the target population N, $n \in N$, that coincides in meaning with regulated procedures that predicate development of statistical tables.

In processing the experimental or field sampling data two typical cases are usually considered. In the first case, the approximating function is limited to a range of given points and only serves as an interpolating function. In the second the approximating function acts as economic and statistical regularities, such as functions or equations of *Tornquist* (*Tornkuist functions*), and this function is an extrapolation of effective forecasting of variable elements. Here is full-scale data serving as reference points for identifying patterns of change, say, $y = f(x_i)$ with known boundary conditions and the resultant variable y and the independent variable is formed on the basis of any significant signs − x_i.

The shape of the equation is selected by the researcher in accordance with the behavior of the approximated function in the relevant range of the independent variables. The result of solving the problem of approximation are the parameter estimates (coefficients) of this equation. Obviously, the coefficients of the equation should be selected so that the values calculated by the equation of the response function are as close as the observations in the original table processed or measured according to the required specifications.

The second Tornquist equation as a function of demand for goods necessary second (less urgent) in relation to the empirical level of demand for the *j*-th good is as follows:

$$y_j^{(i)} = y_j(x_i) + \varepsilon_i = \frac{a_0(x_i - a_2)}{x_i + a_1} + \varepsilon_i,$$

$$a_0, a_1, a_2 > 0.$$

(3)

Configuration equations and laws describing them as acceptable to describe the formation of demand for individual *j*-th household services repair and restoration, relatively expensive tourist products and consumer goods of the second row (less urgent), high-quality food products (including premium) and so forth. The dependence has the following appearance, shown in Fig. 1.

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[1] The group of equations is named for L. Tornquist, a famous Scandinavian econometrics expert in the field of statistics of supply and demand [10].

$y_j^{(i)}, thous. rub.$
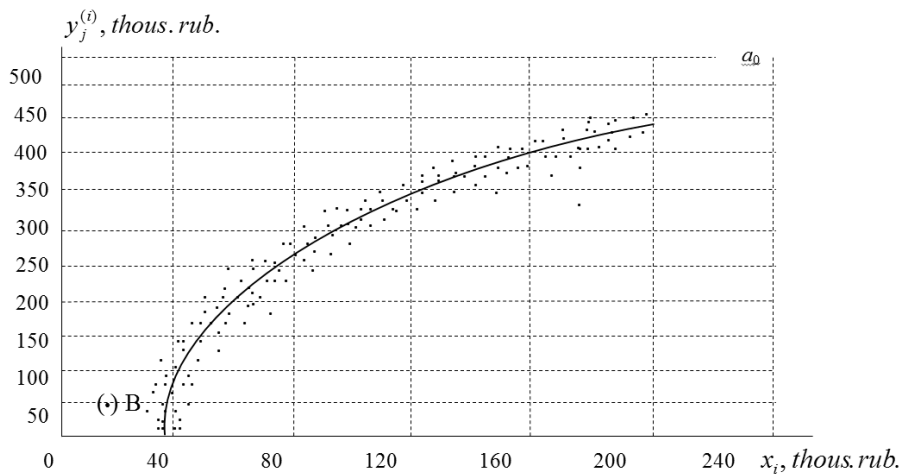
at (•) B: $y_j(x_i) = 0$, which is numerically equal to $x_i^{(0)} = a_2$

Fig. 1. The general behavior of the 2nd Tornquist equation, the demand
for the *j*-th type of tourism products, depending on family income
of the *i*-th income group in the field of empirical data

This feature has its limit a_0, but a higher level than in the first Tornquist equation; while the demand for this group of products occurs only after income of the consumer a_2 that is cut off on the *x*-axis reaches the corresponding income segment $x_i^{(0)} = a_2$. Graph of the same function is a concave curve in Fig. 1, i. e. a concave function for each arc of the curve is not lower than its chord chart converted concave downward (convex upward).

The equation of the expression (1) of auxiliary transformations, such as logarithms, the change of variables and substitution, to linear form is not given. Therefore, it is difficult to estimate the so-called 'true' values of the parameters $\hat{a}_0, \hat{a}_1, \hat{a}_2$ of this equation. Applying the same procedure, the *OLS*, with a single step to form a statistical estimation

$$y(x_i)x_i = -a_0a_2 - a_1y(x_i) + a_0x_i, \qquad (4)$$

supposedly linear with respect to parameters and variables of the equation, as does N.M. Světlov [4], is not correct, since the form of the expression (4 in the original source of the original recording with an asterisk*) cannot be divided on the dependent and independent variables on the right and the left side of the form.

But the value of the 2nd Tornquist equation for analysis and prediction is high, as the parameters of bread need to be known, and in such cases it may be recommended to use the method of successive approximation of the iterative type of task stochastic approximation, which is carried out in several stages (steps).

The initial (approximate) values of the parameters of the equation of the expression (3) for the three pairs of values from the Tab. 1 can be estimated in any way. These initial values generally do not coincide with the true and can be found by solving the system of nonlinear equations consisting of Tornquist functions and with a unique root.

$$\begin{cases} y_j^{(1)} = \dfrac{a_0^{(0)}(x_1 - a_2^{(0)})}{x_1 + a_1^{(0)}}; \\[2ex] y_j^{(2)} = \dfrac{a_0^{(0)}(x_2 - a_2^{(0)})}{x_2 + a_1^{(0)}}; \qquad (5) \\[2ex] y_j^{(3)} = \dfrac{a_0^{(0)}(x_3 - a_2^{(0)})}{x_3 + a_1^{(0)}}, \end{cases}$$

where $y_j^{(1)}, y_j^{(2)}, y_j^{(3)}, x_1, x_2, x_3$ are the empirical values of sample data, for example, three pairs of data from Tab. 1 of revenue and expenditure groups of families taken from each third of the span variation on the grounds x_i.

1. The first stage involves the solution of a system of equations of the expression (5), the exact location of its roots with respect to the initial values of the parameters $a_0^{(0)}, a_1^{(0)}, a_2^{(0)}$ is carried out by the Gauss-Jordan method. The approximate values are found this way, as a set of numbers-roots $a_0 = a_0^{(0)}, a_1 = a_1^{(0)}, a_2 = a_2^{(0)}$, and they differ from the true values of the parameters $\hat{a}_0, \hat{a}_1, \hat{a}_2$ by the value of the relevant correction α, β, γ^3.

Table 1

Background information for the approximate estimation of parameters of the 2nd Tornquist equation by the incremental iteration method

Number family group p/p	Average family income per month for the group, thous. rub.	Average costs for j-th tourist product*, thous. rub.
$i := \overline{1, n}$	$\overline{x}_i$	$\overline{y}_j^{(i)}$
1	**2**	**3**
1	45.0	100.0
2	80.0	300.0
3	120.0	400.0
4	160.0	450.0
5	200.0	490.0

* Calculated by the author for the relatively expensive tours to Mexico, South America and South Africa, based on a panel survey of consumers' budgets in St. Petersburg in 2012−2013. Grouped on a *large sample* volume of 142 units (households), as shown in Fig. 1, in five income groups from Tab. 1[2].

2. The second stage involves a statistical evaluation of these amendments, which allows to set the so-called true parameters

$$\hat{a}_0 = a_0^{(0)} + \alpha, \ \hat{a}_1 = a_1^{(0)} + \beta, \ \hat{a}_2 = a_2^{(0)} + \gamma. \quad (6)$$

To this end, let us substitute a separate 2nd Tornquist equation from the expression (3), as a function with yet unknown true parameters $\hat{a}_0, \hat{a}_1, \hat{a}_2$, taking into account the amendments of the expression (6)

$$y_j(x_i) = f(\hat{a}_0, \hat{a}_1, \hat{a}_2, x_i) = \\ = f(a_0^{(0)} + \alpha, a_1^{(0)} + \beta, a_2^{(0)} + \gamma, x_i). \quad (7)$$

Let us expand the function of the expression (7), regarding the arguments $a_0^{(0)}, a_1^{(0)}, a_2^{(0)}$ and corrections α, β, γ as increments in the vicinity

---

[2] Since the distribution of family members per capita income is not significant, the average potential error sample average μ_y cost indicators for typological sample by the method of mechanical selection calculated by the formula $\mu_y = \sqrt{\dfrac{\sigma_y^2}{n}\left(\dfrac{N-n}{N-1}\right)}$.

of the vector $\vec{a}_k^{(0)} = (a_0^{(0)}, a_1^{(0)}, a_2^{(0)})$ as a point estimate and the coordinates of the point A in Euclidean space E^n; $A \in E^n$, in an infinite Taylor series. As is known, the Taylor series is an expansion of a given analytic function in an infinite amount of power characteristics with respect to a nodal point with coordinates at point A of a three-dimensional space. The function is infinitely differentiable around $(\cdot)$ A, when $a \in [a_0^{(0)}, \hat{a}_0]$; $\beta \in [a_1^{(0)}, \hat{a}_1]$; $\gamma \in [a_2^{(0)}, \hat{a}_2]$.

The specified number is converging on the surface $\hat{a}_0, \hat{a}_1, \hat{a}_2$, as shown in Fig. 2, where the first positive octant with the surface on the positive corrections also designated as α, β, γ is depicted schematically for ease of interpretation, and it looks like a continuation of the power series expansion formula of the expression (7) for the partial derivatives of the initial parameters $a_0^{(0)}, a_1^{(0)}, a_2^{(0)}$

$$y_j(x_i) = f(a_0^{(0)}, a_1^{(0)}, a_2^{(0)}, x_i) + \\ + \alpha \frac{\partial f(x_i)}{\partial a_0^{(0)}} + \beta \frac{\partial f(x_i)}{\partial a_1^{(0)}} + \gamma \frac{\partial f(x_i)}{\partial a_2^{(0)}} + R_s(\alpha, \beta, \gamma), \quad (8)$$

where $R_s(\alpha, \beta, \gamma)$ is the remaining term of the expansion of the original series.

Component $R_s(\alpha, \beta, \gamma)$ is a part (residual term of the expansion-type form of the *Lagrange or Peano*) consisting of partial derivatives of higher order than the first, in combination with the corresponding infinitesimal quantities (*ISQ*) α, β, γ of the second order and above, for example

$$\alpha\beta \frac{\partial^2 f(x_i)}{\partial a_0^{(0)} \partial a_1^{(0)}}; \quad \beta\gamma \frac{\partial^2 f(x_i)}{\partial a_1^{(0)} \partial a_2^{(0)}}; \quad \alpha\gamma \frac{\partial^2 f(x_i)}{\partial a_0^{(0)} \partial a_2^{(0)}}; \\ \alpha^2 \frac{\partial^2 f(x_i)}{(\partial a_0^{(0)})^2}; \quad \beta^2 \frac{\partial^2 f(x_i)}{(\partial a_1^{(0)})^2}; \quad \gamma^2 \frac{\partial^2 f(x_i)}{(\partial a_2^{(0)})^2}. \quad (9)$$

All members of the decomposition, shown in equation (9), are infinitely small quantities of higher order of smallness, which can be neglected according to the theorem about the properties of infinitesimals (the algebraic sum of a finite number of infinitesimal is an infinitesimal). Therefore, members should be limited to no more than the expansion of the second order, $\because R_s(\alpha, \beta, \gamma) \to 0$, with the volume of observations $n \to \infty$.
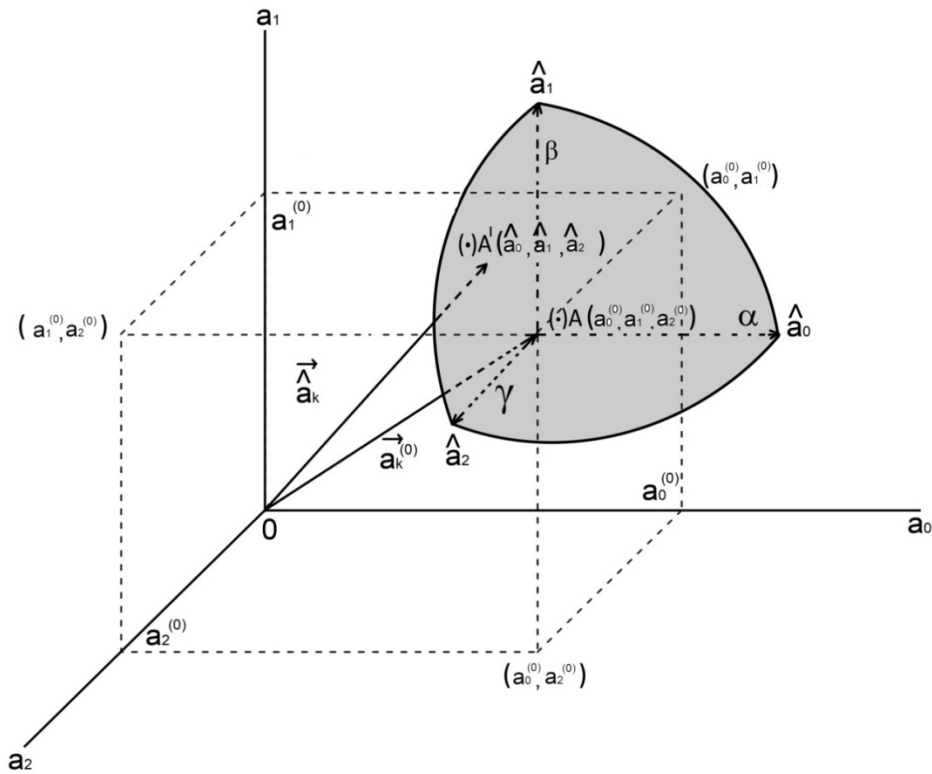
Fig. 2. Geometric interpretation of the implementation of the estimation procedure of the parameters of the 2nd equation by the Tornquist approximation method of successive approximations

3. Finally, the third stage is the last step of statistical estimation of the parameters of a simple regression. Let us designate the first partial derivatives of the formula in expression (8) through respective new variables

$$\frac{\partial f(x_i)}{\partial a_0^{(0)}} = z_1^{(i)}; \quad \frac{\partial f(x_i)}{\partial a_1^{(0)}} = z_2^{(i)}; \quad \frac{\partial f(x_i)}{\partial a_2^{(0)}} = z_3^{(i)}. \quad (10)$$

Keeping in mind that the difference between the empirical and theoretical values of the function of demand for tourist products of the j-th species for $\forall x_i \in [x_1, x_n]$ is the residual vector $\vec{\varepsilon} = \vec{Y} - \vec{Y}(X)$, the expression of the formula (1) can be visually simplified by writing it in the form of multiple regression equations of linear type with new declared variables $z_k^{(i)}$ and amendments in the form of parametric regression coefficients. The latter, in turn, are subject to statistical estimation regression intermediate residual vector $\varepsilon_i^{(0)}$

$$\varepsilon_i^{(0)} = \alpha z_1^{(i)} + \beta z_2^{(i)} + \gamma z_3^{(i)}, \quad (11)$$

where $\varepsilon_i^{(0)}$ characterizes the random component of the vector of demand $\vec{Y}$ and theoretical levels of demand, calculated by the function with the initial

parameters $y_j(a_0^{(0)}, a_1^{(0)}, a_2^{(0)}, x_i)$. Component $\varepsilon_i^{(0)}$ obviously does not generally coincide with a random component, i. e. $\subset \varepsilon_i^{(0)} \neq \varepsilon_i$. Otherwise, assuming they are equal, it will be necessary to prove the properties of the *additive* components for each case of a set of new variables $z_k^{(i)}$ [5] ratios $\varepsilon_i = \varepsilon_i^{(0)} + R_s(\alpha, \beta, \gamma)$.

Correction coefficients α, β, γ in (11) are common (ordinary) *OLS* estimates which solve the system of normal equations constructed by the so-called «*mechanical*» method based on the source of the linear multiple regression equation

$$\begin{cases} \sum_{i=1}^{n} \varepsilon_i^{(0)} z_1^{(i)} = \alpha \sum_{i=1}^{n} (z_1^{(i)})^2 + \beta \sum_{i=1}^{n} z_1^{(i)} z_2^{(i)} + \gamma \sum_{i=1}^{n} z_1^{(i)} z_3^{(i)}; \\ \sum_{i=1}^{n} \varepsilon_i^{(0)} z_2^{(i)} = \alpha \sum_{i=1}^{n} z_1^{(i)} z_2^{(i)} + \beta \sum_{i=1}^{n} (z_2^{(i)})^2 + \gamma \sum_{i=1}^{n} z_2^{(i)} z_3^{(i)}; \\ \sum_{i=1}^{n} \varepsilon_i^{(0)} z_3^{(i)} = \alpha \sum_{i=1}^{n} z_1^{(i)} z_3^{(i)} + \beta \sum_{i=1}^{n} z_2^{(i)} z_3^{(i)} + \gamma \sum_{i=1}^{n} (z_3^{(i)})^2. \end{cases} \quad (12)$$

The algorithm for solving systems of normal equations by the Gauss−Jordan method consists of the series of similar steps, each of which are

made in the mode of action of turn-based iteration of the procedure using the following steps:

1. Check whether the system of equations is inconsistent; if the system contains some contradictory equation, it is inconsistent;

2. Check the possibility of reducing the number of equations; if the system contains the trivial equation, it is eliminated;

3. If the system of equations is permitted, then write the general solution of the system, and if necessary, the particular solutions;

4. If the system is not permitted, the equation does not contain the allowed unknown, choose the respective resolution element and convert this item by the Jordan method. Further re-transfer to the n. 1 incremental iteration.

Methods for solving systems of linear algebraic equations of the type shown in (12), are mainly divided into two groups of methods:

a) *exact methods*, which are finite algorithms for computing the roots (matrix method, Cramer's rule, Gauss et al.);

b) *iterative methods* to get the roots with a given accuracy by converging processes.

It should be noted that the reduced form of the system of normal equations of linear type on the right contains the terms containing unknown quantities of corrections, while the order of the arguments in each equation must be strictly identical.

Parameters $\hat{a}_0$, $\hat{a}_1$, $\hat{a}_2$ defined by successive approximation have statistical properties of unbiased parameters, i. e. $E(\hat{a}_{kn}) = \hat{a}_k$; $E\{|\hat{a}_{kn} - a_k|\} = 0$, and the expectation coincides with the true estimate of the parameter. In other words, mathematical conditional expectation (MCE) sampling rate is zero for $\subset n\uparrow$ and/or $n \to N$, where N is the number of specific general population, such as the set of all families of St. Petersburg in the specified range of income levels. Everything happens for a linear regression model with respect to the residual vector.

However, it should be recognized that in the most general case, these parameters are not optimal estimates as they do not exhibit an asymptotic increase in the volume efficiency in the sample $\{n\}\uparrow$, i. e. are not fully effective estimates in the traditional sense of the properties of the *OLS* estimates. Therefore, an additional check should be carried out at the level of significance of 5.0 % ($p < 0.05$) as the parameters of the regression, and actually the 2nd Tornquist equation.

The level of *p*-values confirms how such an event would be unexpected (the fact) that the data correspond to the null hypothesis H_0. Small *p*-values indicate greater surprise for the discovery of this fact and the reasons for the refusal by analyst H_0. The hypothesis H_0 should be rejected when *p*-values less than the value of 0.05.

In order to assess how reliably the parameters $\hat{a}_0$, $\hat{a}_1$, $\hat{a}_2$ of the study reflect the formation of demand for an expensive tourist product and whether these values are the result of the impact of random variables, we calculated the average error of sample parameters − the calculated error in the general case $\Delta\hat{a}_k$ with the corresponding dispersion characteristics $\sigma_{\hat{a}_k}$, σ_x, σ_y, and the pair correlation coefficient $r_{y|x}$, and Student's *t*-tests

$$\Delta\hat{a}_k = \frac{|\hat{a}_k|}{\sigma_{\hat{a}_k}} = \frac{|\hat{a}_k|\,\sigma_x\sqrt{n-2}}{\sigma_y\sqrt{1-r_{y|x}^2}}. \qquad (13)$$

The conducted calculations showed a relatively high quality of analytical smoothing − the coefficient of determination was equal to $d_y = 0.8376$, i. e. in general variability of the resultant variable 83.76 % it can *explain* the variation of the income factor x_i.

The calculated characteristics of the parameters $\hat{a}_0$, $\hat{a}_1$, $\hat{a}_2$, are shown in Tab. 2.

Due to the fact that a circle of people with incomes well above 200 thousand rub. per month per family member forms quite a significant group of the population of Russia, of particular interest is the capacity assessment of the market of expensive tourist products (individually developed routes to destinations in expensive, prestigious and world-renowned resorts and so on.) for solvent, successful Russians vacationing and traveling several times a year. The study of the capacity of the exclusive Russian market can be made by considering the above-built economic-statistical model.

The consumer market has impressive volumes, since Russia holds one of the first places in the world for the inequality of distribution of property and income. This is stated in the annual 2013 study of the *Credit Suisse Research Institute* (*CSRI*) which reported that in Russia, 110 billionaires control up to 35 % of the wealth of all households, while the average in the world is 1−2 %. The number of US dollar millionaires is estimated in Russia at 84,000 persons [8].

№ p/p	Name countable characteristics	Parameters of the 2nd Tornquist equation, thous. Rub.		
		$\hat{a}_0$	$\hat{a}_1$	$\hat{a}_2$
1	The level of the true parameter	633.3940	133.3840	35.7895
2	The estimated error parameter from equation (13)	2.026808	0.5736	0.1365
3	The lower limit of the confidence interval	627.3134	131.6059	35.3815
4	The upper limit of the confidence interval	639.4746	135.1621	36.1975
5	p-values at 5 % significance level	0.000347	0.000211	0.000076

Together with a world leader in market research, the research firm *AC Nielsen*, *CSRI* published the results of the second annual survey *Emerging Consumer Survey*, a detailed study of consumer sentiment in the *BRIC* (*Brazil, Russia, India and China*) countries. The study sought to identify the specificity of the cost structure and consumer preferences of the population in these countries, which are at the heart of structural changes in world demand. The main structural feature that characterizes the consumers of these countries and their optimism is in the transition from essential to more discretionary spending (*discretionary spending* is the spending on big ticket items), which is more typical for developed economies. It reflects the global changes in the balance of consumer spending.

Despite the fact that the prices of exported raw materials in recent years were still favorable for the Russian economy, a noticeable effect on the average consumer spending is not observed. The level of optimism is still one of the lowest in the *BRIC* countries. Taking into account the income inequality, the growth opportunities in Russia were provided for the general population with the highest income in the segment of discretionary purchases.

The *CSRI* analysts recorded an increase in Russian discretionary spending in different categories, particularly in the category of expensive goods, including technology products, luxury goods and real estate abroad. It has two simple explanations. Firstly, due to a marked significant income inequality and prominent inflation, high-income consumers still actively make expensive purchases. Second, the domestic market of discretionary items such as watches,

smartphones, antiques, fashion clothing, cosmetics, perfumes, tourist products remains clearly *underutilized*, with a further structural growth. Our ordinary millionaire will continue to increase their discretionary spending.

Conclusion. The considerations expressed in this article lead to three local conclusions on the applicability of the procedure in question in dealing with similar ones on the content of economic and statistical research problems of supply and demand for a high level of tourist products [7]:

1. In the epistemological and methodological aspects the formulated problem of estimating the parameters by a typical nonlinear technique (sequential iterative procedure) does not give a final decision, i. e. the results are incomplete and not fully statistically accurate.

2. Because of the inherent rounding even reliable and accurate measures of economic parameters are approximate. When using iterative procedures, an approximation error is added to the actual implementation of the method, and its effectiveness depends on the more or less successful choice of initial conditions approximation and the convergence rate of the iteration process.

3. Finally, a common approach to stochastic approximation of a nonlinear function is understood by the authors through the use of Taylor series and polynomials search for suitable forms. In particular, the linearization of the equations of simple regression with typical nonlinearity must be carried out by the power series expansion with all members of the first order of smallness eliminated from further calculations.

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REAL OPTIONS IN THE INFORMATION SYSTEM DESIGN

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РЕАЛЬНЫЕ ОПЦИОНЫ В УПРАВЛЕНИИ ПРОЕКТИРОВАНИЕМ ИНФОРМАЦИОННЫХ СИСТЕМ

The article reviews the prerequisites to use real options in the design of information systems (IS) as a variety of investment designing. On the one hand, these presuppositions include the risk and uncertainty in the long process of designing and, on the other hand, the possibility to demonstrate the managerial flexibility of the project manager. The main factors of uncertainty and risk include the functionality of IS, requirements to which are approximately formulated by the customer, and then are necessary to be clarified at every stage of the design in accordance with the changing circumstances and the project financing possibilities. The assessment methods of real options such as the Black−Scholes model, binary tree, etc. require initial data that are difficult and even impossible to obtain while designing enterprise information system due to the insufficiency of statistics that characterize the cash flows of such projects. Furthermore, these models ignore the features of the IS design that could be reflected in an optional approach to design. The features of the optional approach to IS design are analyzed and summarized in four groups: 1) factors of uncertainty and risk; 2) the variant approach to design; 3) staging of the design process; 4) the iterative nature of the design process. The classification of types of real options in the design process is proposed. The factors of management flexibility by design stages and types of real options are analyzed. The work offers a consistent economic efficiency assessment of IS based on the expected values of the expanded net present value of the project that are confirmed at every stage of the design. The formula of the expected value of the cost of a real option for binary development of the design process is proposed. The use of real options in the information system design, taking into account the peculiarities of this process, makes it possible to improve the economic efficiency of the project and its attractiveness.

REAL OPTIONS; INFORMATION SYSTEM DESIGN PROCESS; MANAGEMENT FLEXIBILITY; OPTIONAL APPROACH FEATURES; EXPANDED NET PRESENT VALUE; TYPES OF REAL OPTIONS; THE DESIGN STAGES; CONSISTENT EFFICIENCY ASSESSMENT.

Рассматриваются предпосылки целесообразности использования реальных опционов в управлении проектированием информационных систем (ИС) как разновидности инвестиционного проектирования. К этим предпосылкам относятся, с одной стороны, наличие факторов риска и неопределенности в длительном процессе проектирования, с другой − возможности проявления управленческой гибкости менеджером проекта. В качестве основных факторов неопределенности и риска рассматриваются функциональность ИС, требования к которой первоначально заказчиком формулируется достаточно приблизительно и подлежат обоснованному уточнению на всех стадиях проектирования в соответствии с изменяющимися обстоятельствами, а также возможности финансирования проекта. Методы оценки реальных опционов, такие как модель Блэка−Шольца, бинарного дерева и др., требуют использования исходных данных, которые трудно, а в ряде случаев невозможно получить в процессе проектирования ИС промышленных предприятий из-за недостаточности статистических данных, характеризующих денежные потоки данных проектов. К тому же эти модели не учитывают особенности проектирования ИС, которые могут быть отражены в опционном подходе к проектированию. Анализируются особенности опционного подхода в проектировании ИС, сведенные в четыре группы: 1) наличие факторов неопределенности и риска, характерных для проектирования ИС; 2) вариантный подход в проектировании; 3) стадийность процесса проектирования ИС; 4) итерационный характер процесса проектирования ИС. Предлагается классификация видов реальных опционов в процессе проектирования. Анализируются факторы управленческой гибкости по стадиям проектирования и видам реальных опционов. Предлагается последовательная оценка экономической эффективности ИС на основе ожидаемых значений расширенной чистой приведённой стоимости проекта, уточняемых при переходе от одной стадии к другой. Предлагается формула ожидаемого значения стоимости реального опциона для бинарного развития процесса проектирования. Применение реальных опционов в процессе проектирования ИС с учетом особенностей этого процесса позволяет повысить оценку экономической эффективности проекта и его привлекательность.

РЕАЛЬНЫЕ ОПЦИОНЫ; ПРОЕКТИРОВАНИЕ ИНФОРМАЦИОННЫХ СИСТЕМ; УПРАВЛЕНЧЕСКАЯ ГИБКОСТЬ; ОСОБЕННОСТИ ОПЦИОННОГО ПОДХОДА; РАСШИРЕННАЯ ЧИСТАЯ ПРИВЕДЕННАЯ СТОИМОСТЬ; ВИДЫ РЕАЛЬНЫХ ОПЦИОНОВ; СТАДИИ ПРОЕКТИРОВАНИЯ; ПОСЛЕДОВАТЕЛЬНАЯ ОЦЕНКА ЭФФЕКТИВНОСТИ.

Introduction. Improving the economic flexibility of the investment projects, which are characterized by a high risk and uncertainty degree, requires a flexible management of the design process, considering the changing conditions. This accounts for the interest to use real options in the investment projects based on the managerial flexibility [1, 14, 16].

Enterprise information system projects represent a variety of investment projects, which are characterized by a volatility in external and internal environment. Therefore, they require the managerial flexibility in a long design process [2, 3]. According to the results of the research [10, 11], only 26 % of investment projects completed successfully in industrialized countries. Moreover, 46 % of them did not produce tangible results and 28 % discontinued. This data show a lack of accuracy of currently used methods of the economic efficiency assessment of investment projects.

The use of real options in investment projects allows increasing the assessment of their expected economic efficiency. If Net Present Value (NPV) is used as a conventional indicator of the economic efficiency of an investment project [5], this indicator could be increased to the value of the expended Net Present Value (eNPV) taking into account the value of the option [1, 15]. Thus,

$$eNPV = NPV + ROV, \qquad (1)$$

where ROV − Real Option Value.

There are several papers concerning the use of the real options in investment projects, including papers of Limitovskiy M.A. [1], Ilyin I.V. [2], etc.

Methods and models of economic efficiency assessment of real options such as the Black− Scholes model, binary tree and others became well-known [1, 2, 8, 9]. However, these models and methods require using raw data, which are difficult, and in some cases impossible to get while designing enterprise information system of enterprises. It happens due to the insufficiency of statistics that characterizes the cash flows of such projects. In addition, these models and methods do not take into account the features of the information systems design, which can be reflected in the optional approach to design.

Problem statement. The use of real options in the information system design could be based on drawing a decision tree taking into account the peculiarities of the design process.

The task solution requires:
− establishing the main features of the information system design process that makes it possible to use the real options;
− offering a quantitative assessment of the expected value of a real option;
− setting the order of the economic efficiency assessment of the information system based on expected values of the expended Net Present Value by design stages;
− clarifying the classification of the real options in the information system design process;
− matching the factors of the managerial flexibility and the types of the real options by the design process stages.

Research technique. The main features to use the optional approach to the information system design are:
1. The presence of uncertainty and risk peculiar to information system design.

These factors are reflected in the contradictory values of generalized indicators of the information system project constituting the so-called compromise quads [3]:
− The information system functionality;
− The development cost;
− The development duration;
− The design documentation quality.

The opportunity to change the course of the project provides the project manager with the basis of insurance risks of investing in the project. The analysis of project risks and the possibility to reduce them by means of the managerial flexibility are provided by the well-known methods of the information system efficiency assessment TEI (Total Economic Impact) in addition to the comparison of costs and benefits [12].
2. The variant approach to the design.

The managerial flexibility should be visible in the organization and planning a multivariable design process, and not an exclusive variant of the information system development. It raises the possibility to choose the most effective design solutions [3]. The variant approach provides the the basis for applying real options in the information system design.

Let us estimate the value of eNPV and ROV in case of a two-variant approach to the solution made by the project manager based on the value of the NPV. The Fig. 1 shows the decision tree in a two-variant design.
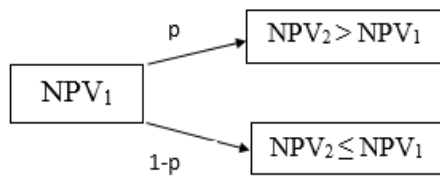
Fig. 1 The decision tree in a two-variant design.

Fig. 1 shows the following notations:

NPV_1 — the expected value of the Net Present Value of the information system project for the first variant of its implementation;

NPV_2 — the expected value of the Net Present Value of the information system project for the second variant of its implementation;

p — the expert probability that the value of NPV_2 would be higher if the second variant is chosen;

$1 - p$ — the expert probability of the opposing event.

Obviously, the project manager will approve the second option, if it does not contradict the valid investment and other restrictions.

In accordance with the basic principles of the approach to real options [13] the project manager has the ability, but not the obligation, to choose the second variant, because he knows the value of the NPV of the second variant. Obviously, the second option would not be selected in case when NPV2 ≤ NPV1, and the project manager would choose the first variant.

The expected value of eNPV according to the optional approach would be

$$eNPV = pNPV_2 + (1 - p)NPV_1 - k_{пр}, \quad (2)$$

where $k_{пр}$ — extra development costs of the second variant of project.

That is why

$$eNPV = NPV_1 + p(NPV_2 - NPV_1) - k_{пр}, \quad (3)$$

The expected value of ROV is

$$ROV = eNPV - NPV_1. \quad (4)$$

That is why

$$ROV = p(NPV_2 - NPV_1) - k_{пр}. \quad (5)$$

From (5) it follows that the higher the expert probability of improvement of NPV for the second variant of the project is and the higher the expected increment of the NPV, when the second variant is chosen, the greater the value of ROV will be.

From (5) it also follows, that the expected result of re-design should surpass its cost to make positive the value of a real option.

A variant approach relates primarily to the functionality of the information systems and the implementation of the principle of the new challenges that identify the relevant issues of enterprise management and key success factors of informatization.

A variant approach also applies to the choice of organizational design technologies, information and software of the technical means, the order of the implementation of information system subsystems [3, 6]. This selection is carried out with a focus on the possibility to finance the project, required development time and required quality of design documentation. Fig 2 shows the classification and the composition of the possible real options in the information system design.

Fig. 2 shows options CALL that provide investment in the project, except for the option to withdraw from the project (option PUT).

3. Stages of the process of the information system design.

With regard to the information system development, the sequence of the design process consists of the following steps:
— The preparatory stage to form an application for design;
— The predesign stage;
— The technical design stage;
— The detailed design stage;
— The commissioning stage;
— The support step.

The transition from one stage of design to other one is accompanied by more managerial decision-making information for the project manager and the ability to refine the economic efficiency assessment of the information system.

Table presents the main factors of the managerial flexibility in the design process in relation to the types of real options and the economic efficiency assessment.

As we see in Table, the flexibility of management decisions can occur at all stages of the design process and it covers management decisions to extend or reduce functionality and scalability of the information system, as well as the deferral of the initial design and adjustment of the length of its separate stages. Furthermore, leaving the project is possible if during the development process the project is found ineffective.
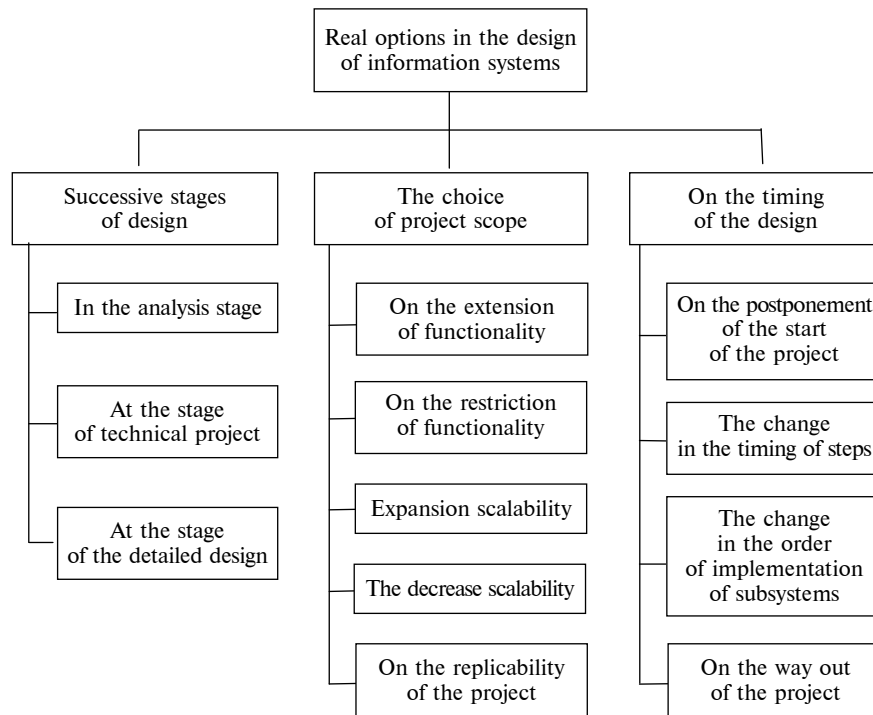
Fig. 2. The classification of the real options in the information system design

The main factors of the managerial flexibility in the design process

The design stage	Types of real options	The main factors of the managerial flexibility in the design process	The economic assessment efficiency of the information system
1. The formation of the design assignment	−	−	Preliminary assessment of the expected cost-effectiveness
2. Analysis: techno-economic assessment of the project and requirement specification development	To expand or contract functionality. To withdraw from the project	Simulation and study of information system functionality, the choice of design technology, the account features of the project financing	The oriented assessment of the expected cost-effectiveness
3. Technical project	To expand or contract functionality. To extend or contract the scalability. To change the timing of steps. To withdraw from the project	The selection and development of algorithms of functional tasks, a database structure, an organizational structure, management, technical support options. The clarification of the composition and number of workstations	The updated estimation of the expected cost-effectiveness
4. Detailed design	To expand or contract functionality. To change the timing of steps. To withdraw from the project. To replicate the project	Software selecting, changes in the composition of the working group and deadlines. The verification of the order of the implementation of the information system subsystems. Accounting for the functioning capacity of the project	The final evaluation of the expected cost-effectiveness
5. Implementation	−	−	The assessment of the actual economic performance

If according to GOST [4] the economic assessment efficiency of the information system is carried out only at three stages of the design (the stage of analysis, technical design and implementation), then while using real options the economic efficiency assessment, in our opinion, should cover all stages of design and be gradually updated from one stage to the next. In addition, the expected evaluation of real options, corresponding to the possible managerial flexibility at the last stages, should be provided.

The value of the extended NPV in the i-th stage can be calculated by the formula:

$$eNPV_i = NPV_i + ROV_i, \qquad (6)$$

where NPV_i − the value of the net present value of the information system project, calculated in a conventional manner at the i-th stage of the design without the managerial flexibility in the subsequent design stages; ROV_i − the expected value of real options that arise at the stages subsequent to the i-th stage.

Both values NPV_i, and ROV_i are gradually clarified from stage to stage, and the opportunities of management flexibility are reduced.

As the main factors of the managerial flexibility of the project manager, which compensate the uncertainty and risks while designing the IS process, the possibility to change the functionality of IS is considered. The customer formulates the requirements to IS approximately and they need to be clarified at every stage of the design in accordance with the changing circumstances and the project financing possibilities.

4. The iterative nature of the information system design.

The iterative nature of the information system design provides the return from the subsequent stages to previous ones to clarify and improve the original design and management decisions, as well as the clarification of the economic efficiency assessment of the information system. The iterative approach is widely used in the information system design and is provided in such models as the incremental, spiral and evolutional [3].

The iterative nature of the design process expands the opportunities of the project manager in terms of the option approach use.

The obtained results

1. The analysis of the main features of the design process, which provide the possibility to use real options, is presented. These features include: the presence of uncertainties and risks, a variational approach in the design, the staging of the design process and its iterative nature.

2. The formula to calculate the expected value of a real option for binary development of the design process is proposed.

3. The order of the economic efficiency assessment of the information system based on expected values of the expended Net Present Value, which are clarified when passing from one stage to another, is recommended;

4. The classification of the real options in the information system design process by the design stages, the scale of the project and timing is clarified.

5. The factors of the managerial flexibility and types of the real options by the design process stages are matched.

The direction for future research. Future research should be focused on the analysis of the practice in the application of real options in the information system design process.

Thus, the use of real options in the information system design, taking into account the peculiarities of this process, makes it possible to improve the economic efficiency of the project and its attractiveness.

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УСЛОВИЯ ПУБЛИКАЦИИ СТАТЕЙ

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