

Generation and Assessment of Intellectual and Informational Capital as a Foundation for Corporations' Digital Innovations in the "Open Innovation" System

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Abstract—The research peruses development of scientifically based toolkit to create and assess promising types of intellectual capital transformed into digital innovations for "open innovation" system. It is determined that in theory terms "intellectual, informational and digital capitals" are interrelated categories; efficient merge of informational and digital capitals minimizes information security risks; merge of informational and digital capitals provides a long-term multiplicative synergetic effect demonstrating constant transformation of innovative ideas into digital innovations. The following is suggested: structural and logical scheme method for creation and assessment of informational capital and scenarios for the synergetic development of informational and digital capitals.

Keywords—*Informational and digital capitals; informational security risks; synergy; open innovation; transformation*

I. INTRODUCTION

In order to keep and maintain high financial corporate status, commercial organizations (corporations) should constantly develop promising trends of intellectual capital generation and its application according to the principle "intellectual capital available in corporation means future potential innovations" in the "open innovation" system. Modern digitalization of business processes calls for digital innovations development that first of all requires intellectual, informational and digital capitals synergy in the "open innovation" system. Timely transformation of intellectual, informational and digital capitals into digital innovations is hampered by the lack of inclusive understanding of the "informational and digital capitals" essence, as well as the processes of their generation, assessment and application. Poor methodological and practical background for creation of a toolkit for generating and assessing intellectual, informational and digital capitals - which could provide for development of digital innovations - limits corresponding

transformation. In this regard, substantiation of theoretical and methodological provisions and practical trends for creation and development of a toolkit for generation and assessment of intellectual informational and digital capitals with its subsequent transformation into digital innovations in the "open innovation" system is a key issue for foreign and national science and practice. Therefore, it determined relevance of the current research topic.

Achievement of the research goal suggests the following tasks: investigation of the essential characteristics of concepts - "intellectual informational capital" and "intellectual digital capital" identifying cross links; consider possibility to transform intellectual, informational and digital capitals into digital innovations in the "open innovation" system.

Working hypothesis of the study is based on the need to develop scientifically based toolkit for intellectual, informational and digital capitals generation and their assessment according to the principle, stipulating that intellectual capital available in corporations means future potential innovations" in the "open innovation" system, which is aimed at further digitalization of business processes in the moment in time and for long-term perspective. Theoretical significance of the study lies in deeper and more expanded understanding of intellectual, informational and digital capitals' generation and assessment, their transformation into digital innovations in the "open innovation" system. Some of the theoretical and methodological aspects of the research are proposed as tutorial and methodological materials for some disciplines of educational programs, as well as for retraining programs and advanced training of the corporations' employees working in the assessment, financial and innovation spheres, etc. Practical significance of the research lies in development and application of specific methods, models and practical provisions that serve to shape

methodological and practical basis for educational processes, assessments of intellectual, informational and digital capitals, and transformation of the latter into digital innovations; that will determine future implementation of a new methodological toolkit that ensures development and promotion of corporations' digital innovations in the "open innovation" system.

The role of intellectual capital in stimulating the transition of healthcare networks to digital technologies is reflected very well in the study of F. Schiavone et al. [1]. In particular they studied creation of an information panel to monitor key performance indicators (KPIs) in digital healthcare networks. It is aimed at improving health policy by means of developing an integrated meso-level structure based on the central role of intellectual capital components (structural, relational, human). In the context of pandemic uncertainty, which demonstrated the need for digital information technologies, the study of K.S. Al-Omouh, D. Palacios-Marqués, and K. Ulrich [2] on the interaction of intellectual capital, supply chain flexibility, collaborative knowledge creation and corporate sustainability during unprecedented crises such as Covid-19 is of high interest. The data was analyzed with the software for modeling structural equations with partial least squares (Smart-PLS). S. Kusi-Sarpong et al. [3] noted the connection of intellectual capital, including human, structural capital, and digital technologies capital - blockchain, embedded in supply chain management that ensures sustainable production.

In the study [4], special attention is paid to determination of the investments impact into intellectual capital as they describe the trends of industrial revolution 4.0 and intellectual capital in the era of FinTech.

E. García-Meca and I. Martínez [5] recognize how information influences intellectual capital while investment decisions making, and point out that certain characteristics of the firm affect the use of intellectual capital information.

Intellectual capital plays strategic role in achieving sustainable development goals and defining future, as noted by G. Secundo, V. Ndou, P.D. Vecchio and G. De Pascale [6]. A. Kalkan, Ö.Ç. Bozkurt and M. Arman [7] point to the connection of intellectual capital, innovation, organizational strategy and firm efficiency, revealing the impact of intellectual capital, innovation and organizational strategy on the activities of the companies operating in Antalya, Turkey.

F. Ricci, V. Scafarto, S. Ferri and A. Tron [8] insist that disclosure of information related to digitalization is a form of disclosure of information about intellectual capital that provides investors with potentially valuable data.

Taking into account the above, recognition of the connection between intellectual digital and information capitals becomes clear as it is the basis for digital innovations development in corporations in the "open innovation" system, which must be constantly improved and developed in the conditions of economic processes digitalization.

II. METHODOLOGY

A. Identification of Intellectual Capital and Innovations Cross Links

Considering that the best method for measuring intellectual, informational and digital capitals, which are the basis for digital innovations' development in corporations in the "open innovation" system, is the method that reflects their economic content and its generation is carried out in the following sequence of stages:

Stage 1: identification of the connection between intellectual capital and innovations. Its result is identification of the resource for innovative activity in corporations in the future, i.e. their intellectual capital.

Stage 2: ensuring the synergy of intellectual capital assessment and innovations, which is based on the principle stating that "intellectual capital available in the corporation is its future innovations". Its result is the determination of the factors for productive reproduction of intellectual capital that limit innovations including organizational innovations.

Stage 3: alternative direction for interpretation and evaluation of the intellectual information capital in corporations. Its result is provision of the characteristics for intellectual information capital in corporations, which is designed to ensure informational security of intellectual activity.

Stage 4: interpretation of the intellectual digital capital in corporations, its interaction with human and informational capital. Its result is justification of the fact that digital innovations represent interconnection of human, informational and digital capitals in "open innovation" system.

Theoretical and methodological foundation of the research: works of the international and Russian scientists and practitioners, Oslo Manual, internal regulatory corporations' framework. Methodological base of the research: system, process and logical scientific approaches to study processes of promising corporative types of intellectual capital generation and assessment aimed at subsequent transformation into digital innovations in the "open innovation" system.

Each stage of the research required general scientific and special methods to achieve proper efficiency, they were: analysis and synthesis, generalization and detailing, inductive and deductive, selective observation, grouping, formalization, analogy, abstract-logical, monographic, analytical, comparative, economic-statistical and economic-mathematical. Information sources were selected for the period of 1998-2022, taking into account the principles of complexity, relevance, transparency, materiality, comparability with the best international practices, consistency, preference, objectivity, reliability, relevance and up to date information .

J. A. Schumpeter [9] essentially connects initiation of innovations with generation of intellectual capital prerequisites. V. L. Inozemtsev [10] clearly names intellectual capital as opportunity for innovations, L.V. Yurieva et al. [11] highlight innovations as organizational intellectual capital element, V. P. Bagov et al. [12] consider it as an intellectual resource that predetermines organization's ability to produce and sell its innovative products.

L. Edvinsson and M. S. Malone [13], B. Lev [14], A. Pulic [15] consider innovative component of organizational intellectual capital as a separate type of capital.

According to J.A. Schumpeter [9] determines practical implementation of scientific and technical initiatives and inventions as the essence of innovation, whereas underlining the meaning of an entrepreneur as a person of business amongst invention and innovation confirms importance of human capital.

Yu. V. Vertakova, E. S. Simonenko [16] point out that accomplishment of an invention or a discovery in a particular human activity area transforms underlying ideas of the invention into an innovation that contributes to new ideas emerge, eventually causing generation of new products (technologies). They associate invention with high-level innovation, defining products and technologies, social, economic, environmental and managerial processes as the subject of change. In the result there is an innovative spiral cycle: "scientific and technological progress - idea - innovation - scientific and technological progress - idea - innovation - ..."

In the Center for Economic and Social Research of the Republic of Tatarstan [17] new phenomenon, discovery, idea, method, etc., presented as a result of research, development / empirical work on increasing particular sphere of business efficiency is called innovation; its implementation creates innovation taking into account condition of human involvement that changes along with development of socio-cultural systems and regions. Innovation is shaped based on investment into new equipment, technologies, regulation

systems, labour organization and etc., that together shape intellectual organizational capital. In general, organizational capital of corporation is assessed according to the principle "inventions available in the patent portfolio mean future innovations".

V.V. Platonov [18] recognizes innovation capital (industrial property, technological know-how) as a part of organizations' intellectual capital along with the network, and human and organizational capitals.

B. Lev's model [14] "Value Chain Blueprint" describes intellectual capital on the basis of corporation's determination for innovations and integrates 9 parameters: internal renewal availability (research, personnel development, organizational processes); integrated acquired abilities (technologies, investment business); intellectual property; technological feasibility for innovations (clinical tests, approvals, prototypes); business networks (alliances, integrated corporations, customers and suppliers associations); customers (marketing alliances, brand value, value, customer drain); business on the Internet (website traffic, online orders, alliances on the Internet); performance (sales, including licenses, profit, market share, new products); future growth (periods for bringing new products to the market, planned initiatives, increase in results, etc.).

Human capital is described along with traditional qualities of a person: knowledge, skills, qualifications, competence, and other characteristics correlated with personality as well as innovations capability.

"Social innovation" term is always put together with the concept of "intellectual capital", which comes up [19] when strengthening human factor via creation and introduction of systems for modernized personnel policy, professional retraining and growth of employees, social and professional adaptation of newly hired, bonuses and assessment of work results. It should be emphasized that K. Marx [20] when characterizing the economic category "capital" underlined its social aspect.

TABLE I. INFLUENCE OF FACTORS ON INTELLECTUAL CAPITAL FOR EVERY THREE PAST YEARS, ACCORDING TO FORM 4 - INNOVATION - ADAPTED FOR ORGANIZATIONS IN STAVROPOL REGION, UNITS

Factors	Factors' impact				
	1 – unessential	2 – essential	3 – crucial	4 – No clear answer	5 – Not applicable
Human capital					
Lack of qualified personnel	137	105	22	185	204
Organizational capital					
Uncertain economic benefits from intellectual property utilization	94	95	27	247	190
Stakeholders' capital					
Lack of own financial resources	66	181	94	157	155
Lack of State financial support	76	159	46	189	183
Lack of information on new technologies	150	70	22	197	214
Lack of information on sales markets	152	64	20	200	217
Underdeveloped cooperation networks	124	67	15	235	212
Underdeveloped innovations' infrastructure (intermediaries, information, legal, banking and other services)	143	68	25	237	180
Total	711	609	222	1215	1161

Source: calculation provided by the authors V.V. Manuylenko, G.A. Ermakova [19]

V.V. Manuylenko, A.A. Mishchenko [21] associate intellectual capital availability with personnel innovations emerge and regular improvement of erudition level with a professional team. Surely there is an opposite effect of intellectual capital sales and social or personnel innovations.

E.V. Petrukhina [22] recognizes following functions of organization's intellectual capital: education and future development of intellectual property; promotion of employees' innovative thinking, businessmen, scientists, and management teams that shape and test key models for reproduction within a single economic system or systems units.

Aggregated intellectual capital, as noted by V.V. Manuylenko, G.A. Ermakova [19], performs the function of corporations' innovative development. In terms of reproductive performance intellectual capital of corporations is simultaneously a prerequisite and result of innovations

creation process showing the result of previous or current innovative activities in the "open innovation" system. I.e., intellectual capital of corporations is a resource for future oriented innovative activities. Following the logics of the research, assessment of both intellectual capital and innovations in corporations is a challenging study issue.

A. Synergy of Intellectual Capital and Innovation Assessment

Considering available intellectual capital in corporations for future innovations, intellectual capital of corporations is assessed according to Form 4 – innovation (adapted). Still, in Form 4 – innovation "Information about organization's innovative activity" the following parts draw special attention: factors limiting innovation and organizational innovations.

Factors affecting each type of intellectual capital in organizations (human, organizational, stakeholders') – Table I.

TABLE II. ASSESSMENT OF POSSIBILITIES FOR CHANGES IN INTELLECTUAL CAPITAL DEVELOPMENT WITH ORGANIZATIONAL INNOVATIONS UTILIZATION IN CORPORATIONS OF STAVROPOL REGION, UNITS

Indicators	YY								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of corporations implementing organizational innovations during past three years	7	4	9	8	6	4	2	3	8
Number of corporations with no organizational innovations	435	459	455	449	438	450	690	650	811
Organizational innovations / Human capital									
Innovations concerning shift working hours	4	3	2	4	2	2	2	1	1
Introduction of corporative knowledge management systems	4	2	3	1	0	2	0	0	2
Personnel development means (corporate and / or individual trainings, creation / development of personnel training and advanced training institutions)	6	4	7	8	6	4	2	3	7
Introduction of new methods for employees motivation	0	0	0	0	0	0	1	0	1
Organizational innovations / Organizational capital									
Development and implementation of new or significantly corrected corporate (shareholders') strategy	5	3	4	5	4	4	2	2	2
Introduction of modern (IT-based) management methods in corporations	6	4	5	5	2	2	2	3	4
Development and introduction of new or significantly updated organizational structures in corporations	7	4	4	5	4	4	2	2	2
Application of modern systems for quality control, certification of goods, works and services	6	3	3	5	4	4	1	2	5
Creation of units specializing in research and development, implementation of scientific and technical achievements (technology and engineering centers, small innovation corporations)	3	2	1	3	2	2	2	1	2
Transferring certain functions and business processes to specializing contractors (outsourcing)	3	2	2	3	4	4	2	1	2
Organizational innovations / Stakeholders' capital									
Introduction of modern logistics and supply systems for raw materials, materials, components ("just in time", etc.)	4	3	3	3	2	1	2	1	4
New forms of strategic alliances, partnerships and other types of cooperation networks with product consumers, suppliers, Russian and foreign manufacturers	2	1	1	3	2	2	2	1	1

Source: calculation provided by the authors V.V. Manuylenko, G.A. Ermakova [19] as per data provided by Federal State Statistics Service for the North Caucasus Federal District [23]

Among the factors affecting intellectual human capital the following should be noted: lack of qualified workers, intellectual organizational capital, i.e. uncertain economic benefits from intellectual property utilization, intellectual stakeholder capital, i.e. factors associated with generation of financial resources: lack of own funds and/or State financial assistance; informational factors: lack of information about new technologies and sales markets; at the same time, such factors as underdeveloped cooperation networks and innovation infrastructure (intermediary, information, legal, banking and other services) should be also taken into account. Among significant financial nature factors that affect intellectual capital of organizations there is a lack of own funds and/or State financial assistance, which is followed by factors of underdeveloped innovation infrastructure, insufficient information about new technologies and sales markets as well as underdeveloped cooperation networks. No clear response was noted for such factors that affect intellectual capital of organizations as uncertain economic benefits from intellectual property utilization, underdeveloped innovation infrastructure and cooperation networks [19]. In general, when determining influence of factors on intellectual (human, organizational, especially stakeholders') capital, first prevail those corporations that have no clear response or with no applicable factors, then there are those that note insignificant, significant and crucial influence.

It should be noted that Form 4 – innovation – combines factors of efficient reproduction of intellectual capital (scientific and technological progress, the level of IT literacy, innovation and intellectual property policies, modern market infrastructure, institutional environment, etc.).

Alternative area for human, organizational and stakeholders' capitals development is organizational innovations. Merged application of intellectual capital and organizational innovation causes overturn of the principle: "intellectual capital existing in the organization means future innovations", ultimately creates opposite effect in the "open innovation" system. Intellectual capital in corporations influences creation and implementation of organizational innovations, which in turn affects intellectual capital, changing the demands, as well as its content (ratio between human, organizational and stakeholders' capital).

In the corporations of Stavropol Region, organizational innovations affect generation of human, organizational and stakeholders' capitals – Table II.

Organizational innovations mainly develop towards improvement of human capital in the area of personnel development (corporate and / or individual training, creation / development of personnel training and advanced training institutions). These organizational innovations serve to minimize risks with personnel insufficient scientific qualifications. From the standpoint of intellectual capital future development it is not good that in the region number of corporations with no organizational innovations prevails (435 - 811 units) over the number of corporations that have ones (2 - 9 units). Increase of corporations that do not carry out organizational innovations makes it difficult to reveal synergistic effect on the principle "intellectual capital

available in the corporation means future innovations" in the "open innovation" system.

In developing countries above human capital, resources and networks Oslo Manual [24] recognizes priority of information and communication technologies, their ownership and application by organizations. By the level of innovative development innovations are classified according to the criterion of technological parameters that takes into account essence of innovations, i.e. complex attraction of new digital, information and communication technologies. In the current environment, information and digital technologies become a priority issue demanding identification of characteristics for human, informational and digital capitals. According to KPMG research, factors hampering introduction of innovative technologies in Russia as well as in the world are insufficient maturity of processes / low automation, low level of IT-literacy of employees. Among the threats for digitalization Russian and world experts recognize the risks of information security, etc. [25-27].

B. Characteristics and Assessment of Corporations'

Intellectual Information Capital: Alternative Point of View

V.A. Medvedev [28] puts together informational capital and level of control over information. V.L. Inozemtsev [10] designates databases as part of structural capital elements. B.B. Leontiev [29], L. Edvinsson and M.S. Malone [13] recognize information systems as constituent parts of organizational capital, and B.B. Leontiev [29] adds up accumulated knowledge bases.

In developing countries, information and communication technologies, their ownership and application by organizations are predominantly distinguished. In 1972, K.D. Arrow [30] identified link between special economic behaviour of intellectual resources and information creating and handling processes.

In existing environment, encoded and materialized information is represented in human capital. According to P.F. Drucker [31], knowledge is "information" that changes something or somebody or else is the cause of action that provides opportunities for different and more effective actions.

Corporations' financial managers should provide access to sources of knowledge and information, which are subsequently transformed into separate production resources for specific use. Constant monitoring of information relevance and demand serves its transformation into corporations' valuable resource, which is ensured only with creation of developed information and communications infrastructure, assumed that only up-to-date information processing technologies and information exchange are applied. IT-specialists categorized as intellectual workers are in demand.

Creation and development of corporations' intellectual capital is subjective to correctly built information exchange system. Paragraph 23 of Oslo Manual [24] pays special attention to information needs of analysts and politicians when they accumulate information about innovation activities or determine set of indicators. According to the golden rule of information mobilization, information exceeding value or its collecting costs makes its accumulation reasonable. At the

same time, it is important to take into account distinctive properties of corporations' intellectual capital, i.e. information asymmetry and liquidity. Processing of information results in knowledge that reflects human capital - when put together it represents powerful competitive tool. Science being one of the constituent parts of intellectual activity produces new knowledge, that is, new information; in order to transform it into knowledge it is advisable to present it and combine it with existing knowledge, establishing value of received information, attributing it to structure (superstructure), and providing guidelines for its application. Thus, knowledge existing in time interval $t + 1$ is a complex functional relation of received information and human knowledge in corporations. As a result, importance of information in creation and development of intellectual capital in corporations, which should meet uniqueness requirement, is confirmed. The link between intellectual information and human capital of corporations becomes evident. In terms of liquidity degree information systems usually have medium liquidity, whereas databases and accumulated knowledge bases are low liquid.

As a result, it is fair to set aside intellectual information capital of corporations intended to ensure information security of intellectual activity; its functioning reveals risks of insufficiency and inconsistency of information capital in the existing environment, etc.

C. Characteristics of Intellectual Digital Capital of Corporations, its Interaction with Human and Informational Capital

Considering that corporations' "intellectual capital" concept is constantly changing over time, and accelerated introduction of digital technologies in economy and social sphere is one of the national development goals [32], intellectual digital capital is of great importance for Russian corporations. Information and digital technologies can ensure operation of corporations 24/7/365. Digitalization represents integration of digital technologies in order to improve project's performance by means of key processes adjustment [33]. Modern digital technologies are focused on transforming traditional business models and business processes in already existing industries. Innovations grounded in digital technologies create new electronic financial products and services and bring up to date their forms.

Technical financial industry having technological foundation shall incorporate provisionally basic end-to-end technologies: telecommunications, Big Data technologies, Internet of Things, industrial and simulated intellect, as well as interdisciplinary technologies: neuro-technologies, distributed ledger systems, elements of robotics and sensor technologies, quantum, new production technologies, technologies of virtual and augmented reality.

Hence, for most corporations, efficient digitalization process indicator represents "digital versions" of already existing conventionally traditional solutions, optimization results for actual business processes, whereas implementation of innovative changes in business models indicates future prospects. Corporations with limited digital technologies may provide basic services, such as balance sheet regulation, in the

"open innovation" system – Table III.

There are criteria for assessing satisfaction level of digital customers: regular compliance of requirements to provided services, timely receipt of information about digital products and services, assessment of the ratio between results and resources spent on digital products and services purchase, risk level at digital products or services receipt, overall satisfaction with digital products and services, digital customer feedback. Creation and development of digital stakeholders' capital in corporations should be aimed at exceeding stakeholders' expectations. It is true that digital stakeholders' capital in its essence represents digital asset value, expressed in relations with stakeholders, i.e. digital clients, which when efficiently managed by a corporation on the basis of special marketing activities maximizes value and ensures competitiveness, and in the quantitative aspect justifies amount of discounted cash flows obtained from real and potential stakeholders, i.e. digital clients, and excludes mobilization costs, that is lifetime value of real and potential stakeholders.

TABLE III. BASIC DIGITALIZATION AREAS FOR CORPORATIONS IN THE "OPEN INNOVATION" SYSTEM

Areas	Digital format functions	Financial technologies
Regulation and assessment of assets and liabilities	Assets and liabilities regulation in digital format	Big Data, block chain
Financial consulting	Financial consulting in digital format	Big Data, artificial intellect
Management Accounting	Online accounting	Cloud technologies
	Online reporting	SaaS
	System solutions	Cloud technologies, block chain
Infrastructure solutions	Identification solutions	block chain, artificial intellect, Big Data, SaaS
	distributed ledger and automated (smart) agreements	artificial intellect, block chain
	Information Security	computer education, artificial intellect, predictive analytics, block chain

Source: information provided by the author V. V. Manuylenko

One of the key corporation's competitive advantages is highly qualified personnel, namely central competence of corporation (capability to digital training and personnel development, infrastructure for long-term future growth) – employees with their own experience and qualifications, as well as unique abilities to digitalize economic processes. According American economist E. Denison study in 1929-1982, American economy growth occurred by 32% due to new labour force mobilization, 1.4% - due to increase of education level, 28% - progress in knowledge; 19% – new investment, 17% – modernization of production structure and labour organization [34]. Top three new key competencies of future demand include: flexible and critical thinking, creativity, emotional intelligence, which distinguish person from machine. Most demanded specialists for implementation of transformation programs are business analysts in process optimization and data analysis. Digitalization and innovation professional personnel should include IT specialists with different background (from data analytics, robotics and

interface design up to cyber security and integration), IT auditors with knowledge and skills in obtaining and analyzing digital information technology data [35], top risk management, internal audit, compliance, experts from other technological organizations that include various types of economic activities and research institutions. Creation, assessment of intellectual digital capital in the “open innovation” system should include professional judgment of specialists.

It is clear that initially digital intellectual capital causes risks of staff deficiency, insufficient level of scientific personnel qualifications and low scientific specialization. At the same time, introduction of financial technologies raises up threats of digital fraud in financial sector, leading to information security risks that also reveals links between intellectual, informational and digital capitals. Risks complementary to corporations’ intellectual digital capital functions are defined as possibility of wrong digital decision making. Synergy effect of merged intellectual, human, informational and digital capitals functioning should ensure development of digital innovations. Hence, digital innovations represent result of human, informational and digital capitals interaction, implementation of which results in relations and links rising up between corporations and digital clients in the “open innovation” system, that represents intellectual digital stakeholders’ capital.

III. RESULTS

A. In Theoretical Block of the Research

- determined that innovative activity in the “open innovation” system derives from corporations’ intellectual capital elements;
- all types of innovations are based on technologies, among which - in the context of digital economy development - informational and digital technologies draw special attention; that makes necessary to research intellectual, information and digital capitals, i.e. basis of digital innovations development in the “open innovation” system;
- established connection between the concepts of organizations’ “intellectual capital” and “social”, “personnel” innovations, which mainly is reflected in strengthened human factor by means of development and introduction of modernized personnel policy systems, regular improvement of personnel / team education level, etc.;
- identified corporations’ intellectual informational capital function in the "open innovation" system, i.e. provision of information security for intellectual activity;
- described supplementary risks of corporations’ intellectual digital capital functioning at initial stage (staff deficiency, personnel scientific qualifications level, low scientific specialization) and subsequent threats caused by digital fraud possibilities in financial sector, leading to information security risks in the system "open innovation".

B. In Practical Block of the Research

- considering that available intellectual capital in corporations represents future innovations, Form 4 – innovation – was adapted to corporations’ intellectual capital assessment in the following areas: factors limiting innovations, organizational innovations;
- found that development of intellectual capital in most corporations is complicated by insufficient consideration of affecting factors (corporations with no answer or no factor prevail, organizational capital is affected by uncertainty of economic benefits from intellectual property utilization) that makes necessary call for professional judgment in assessment process in order to eliminate controversial interpretation of results, errors and manipulations, as well as decrease of corporations that carry out organizational innovations, whereas their influence is noted on building up human, organizational and stakeholders’ capital in corporations of Stavropol Region;
- based on corporations’ intellectual capital assessment according to adapted Form 4 – innovation, its key advantages and disadvantages are identified – Table IV;
- indicated sequence of intellectual capital assessment stages based on adapted Form 4 – innovation, as follows: 1) determination of the factors influencing intellectual capital, 2) assessment of changes possibility in intellectual capital development via organizational innovations, 3) identification of the key advantages / disadvantages of intellectual capital assessment by Form 4 – innovation, 4) generation of motivated professional judgment of specialists;
- found that most corporations consider digitalization processes efficiency indicator in the “open innovation” system as “digital versions” of conventionally traditional existing solutions, results of actual business processes optimization, whereas innovative changes in business models are taken for future projections.

TABLE IV. KEY ADVANTAGES AND DISADVANTAGES OF CORPORATIONS’ INTELLECTUAL CAPITAL ASSESSMENT ACCORDING TO ADAPTED FORM 4 – INNOVATION

Advantages	Disadvantages
Development of scientific level with actually obtained results of intellectual activity.	Lack of internal regulatory framework governing intellectual capital assessment process.
Development of inventive level represents a fact of created patented inventions, and good perspectives for inventing object	Based on non-formalized methods, expert assessments method with subjective nature, which do not represent importance of intellectual capital in added economic value and its impact on the market value.
Development of design level is demonstrated in patented industrial samples and applications of industrial design and exterior of commercial product submitted for patenting.	Tendency to collection of quantitative indicators, and their application without strict analytical dependencies.
Software creation represents	No mechanism for transfer of ideas

object for development of officially registered computer programs and / databases and / purchased applications for the official registration of computer programs and / databases	and high technologies into market products / or intellectual potential into capital
	No mechanism for transforming human and stakeholders' capital into capitalized assets, since market qualifications are recognized via certificates and licenses, reputation – via brands, knowledge – via intellectual property rights.
	No demo effect of ultimate goal from intellectual capital application that breaks main property of capital – its ability to generate income.
	Lack of tools for assessing and regulating risks associated with intellectual capital the functioning.

Source: research provided by the authors V. V. Manuylenko, G. A. Ermakova [19]

C. In Methodological Block of the Research

- established link between human and informational capital, when knowledge in a time period $t + 1$ represents complex function of received information and knowledge of a subject of business – i.e. a person in a corporation;
- determined that informational capital in the “open innovation” system reflects quality of information systems, databases, incorporating efficiency of information application, administrative systems and organizational structures, information products and technologies, etc., eventually performing a function of ensuring information security for intellectual activity;
- proposed that quality of information systems is assessed by means of satisfaction level of internal clients – employees of corporations, taking into account main theoretical and methodological provisions of the assessment – Fig. 1. The following are priorities for modernization projects: automation of information system, improvement of transparency and quality of information, availability of up-to-date information, regularity, efficiency and timeliness of information receipt, importance of regional aspect in information systems operation in terms of global trends. Assessment of satisfaction level with information systems by internal clients allows identify at relatively low costs wide range of problem areas, and represents efficient tool for development of informational capital. It is important that corporative cultures accept informational systems expressing affiliation of informational and cultural capitals;
- merged performance of intellectual, human, informational and digital capitals ensures development of digital innovations, causing synergy effect in the “open innovation” system. In digital economy environment, particularly these types of corporations' intellectual capital penetrating into each other create intellectual wealth, and obtain strategic national importance;
- outlined main areas of digitalization in traditional corporations in the context of functions revealed in digital format and financial technologies in the "open

innovation" system (management accounting - system solutions - cloud technologies, block chains, API; infrastructure solutions - information security - computer learning, artificial intelligence, predictive analytics, block chains, etc.);

- determined that at the initial stage digital intellectual capital is accompanied by risks of lack of personnel, low level of personnel scientific qualifications, low scientific specialization of personnel; subsequently introduction of financial technologies causes threats of developing digital fraud in financial sector, leading to information security risks in “open innovation” system.
- found that synergy of intellectual, informational, digital and human capitals in corporations contributes to development of digital innovations in the “open innovation” system.

IV. DISCUSSION

The authors believe that developed toolkit for creation and assessment of intellectual, informational and digital capitals aimed at digital innovations development requires steady upgrade of information and digital technologies in the “open innovation” system. I. Kukhnin, specialist of Deloitte CIS Research Center [36], evaluated technologies in terms of their potentials as follows: artificial intelligence - 0.88, computer learning - 0.84, predictive analytics – 0.82, deep learning - 0.79, and Big Data - 0.78, block chain - 0.54, augmented reality - 0.58 and virtual reality – 0.55. The best effect of digital technologies application was brought by solutions on Big Data and predictive analytics - 40%, robotization - 38%. Big Data and predictive analytics are used in the following key areas - operational intelligence and analytics - 52%, customer service, sales and marketing - 35% [25-27].

It is important to take into account that information and digital technologies development has certain specifics in corporations in terms of their different business activity types. Analysis of cross sector integration of industrial CIOs from more than 90 countries, conducted by Gartner [37], shows the following ranking of economic activities according to potential impact of digital transformation: media – 30%, banking and investment services – 26%, telecommunications – 25%, insurance and transport – 22%, services – 19%, government – 18%, healthcare – 17%, retail – 15%, housing and utilities, industry – 14%, healthcare providers – 13%, education – 12%, wholesale trade – 11%, natural resources – 7%.

Corporations' digital innovations development implies:

- identification of logical links between the terms: “intellectual capital” and “social”, “personnel” innovations;
- identification of informational capital assessment stages;
- identification of risks linked with intellectual capital creation and application.
- Corporations' digital innovation development is possible in the following areas:

- corporations' digital strategy;
- intellectual capital development trends; separate research of intellectual stakeholders' capital of corporations was carried out by S.S. Galazova et al. [38];
- optimal combination of human, informational and digital capitals: E.A. Posnaya et al. [39], T.V. Shabunina et al. [40]; E.V. Rodionova et al. [41] – regional level;
- complex intellectual capital reproduction: E. Zhilenkova et al. [42];
- intellectual digital capital creation risk management: V.A. Kunin and D. Mikhailovsky [43].

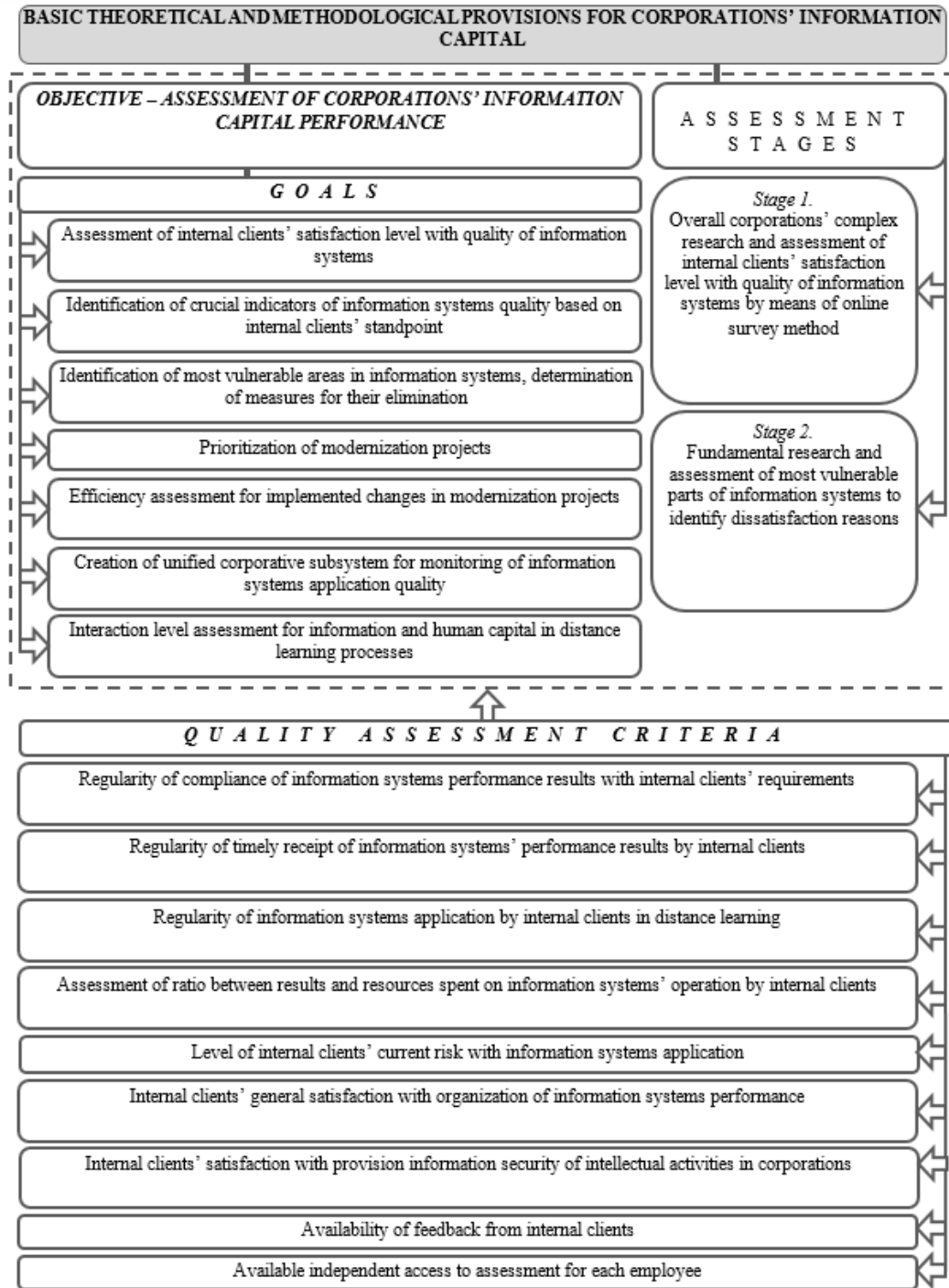


Fig. 1. Logical and Structural Chart for Creation and Assessment of Informational Capital in Corporations (Developed by Authors V. V. Manuylenko, G. A. Ermakova)

V. CONCLUSIONS

It is important to note that development of digital innovations predominately on intellectual, informational and digital capitals foundation in the “open innovation” system serves to reduce research and development costs, create potential for efficiency improving as well as potential synergy between informational and digital innovations. Thus, conception was created and implemented as follows: intellectual informational and digital capitals functioning in corporations simultaneously with human and stakeholders’ capital represent future potential digital innovations in the “open innovation” system. Research possibilities are limited with underdeveloped legislation that regulates digital economics processes, which predetermine development of digital innovations in corporations. Different corporations may independently formulate guidelines for digital innovations development based on proposed scientifically grounded toolkit.

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