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Approaches to the creation of a systemic integrated theory of intellectual capital management

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ABSTRACT: Summary.**:**The present study aims to make its theoretical contribution to the rationale for the creation of an integrated system theory of human capital management and to clarify the interaction of knowledge generation factors in a dynamic innovation system. The systems theory of intellectual capital identifies the mechanisms that ensure the role of intellectual capital in the dynamic innovation capabilities of technology companies and industrial sectors.

Keywords.:Intellectual capital, systems approach, systems modeling, knowledge management, knowledge generation.

INTRODUCTION

The consensus among the business and scientific community regarding the model of intellectual capital management has not yet been determined, although it is customary to consider intellectual capital as the most important asset of innovative companies [1]. On the other hand, companies and organizations that, for various reasons, are not able to properly use the value of intellectual assets, doom themselves to compete using outdated strategies and tactics.

A model for systemic assessment and management of intellectual capital, which could identify, analyze and evaluate intangible assets, conduct an in-depth analysis of the company's activities in terms of intellectual capital, is aimed at identifying the company's market competitiveness potential. Accordingly, the measurement of intellectual capital can differentiate between successful innovative and mediocre uncompetitive companies[2]. For the same companies operating in monopoly markets, models of this type are likely to be irrelevant, which partly explains the almost complete lack of interest in them in public corporations.

In modern science, it is generally recognized that the structure of intellectual capital consists of three areas - human capital, structural capital and client capital[3]. In this context, the most appropriate tool for building a model of intellectual capital management is a systematic approach that allows you to integrate elements of these areas that are different in nature in the general model.

Many theories of intellectual capital reflect the difficulty of finding a suitable model in terms of an acceptable combination of indicators that can be used in the activities of companies. In this regard, the scientific literature notes that "the main conceptual problem of measurement is that knowledge manifests itself in many forms and types."[4] Since the approach to measuring intellectual capital depends on many variables of their activity, it can be difficult to draw clear boundaries between the divisions and relationships of the various measured elements.

In view of the above the first postulate of the system theory suggests that indicators and indicators of intellectual capital separately cannot reflect the multi-level, multidimensional nature of knowledge. An integrated systems model is essential for innovative companies because intangible assets are critical to success in an increasingly competitive marketplace and the external environment. Therefore, the selected indicators make sense for research and monitoring of each specific element from the point of view of analyzing all components of intellectual capital, without preference for one of the sections over others. In this case, several analysis criteria are used: the type of model, the corresponding method used, the formula for calculating intellectual capital, advantages and disadvantages, etc. The model should make it possible to compare different strategies for the innovative development of a company, focusing on monitoring the dynamics of the level of its intellectual capital.

The practical significance of the system model for assessing and managing intellectual capital lies in its ability to periodically offer the management of the company information and analytical data that allow taking corrective measures for the strategy of forming and maintaining long-term and sustainable competitive advantages by extracting and applying knowledge. In today's unstable economic world, in order to survive and dominate certain sectors of production and markets, companies need to constantly develop and strengthen their innovative potential. In this regard, accelerating the processes that underlie innovation is one of the main competitive rates today.

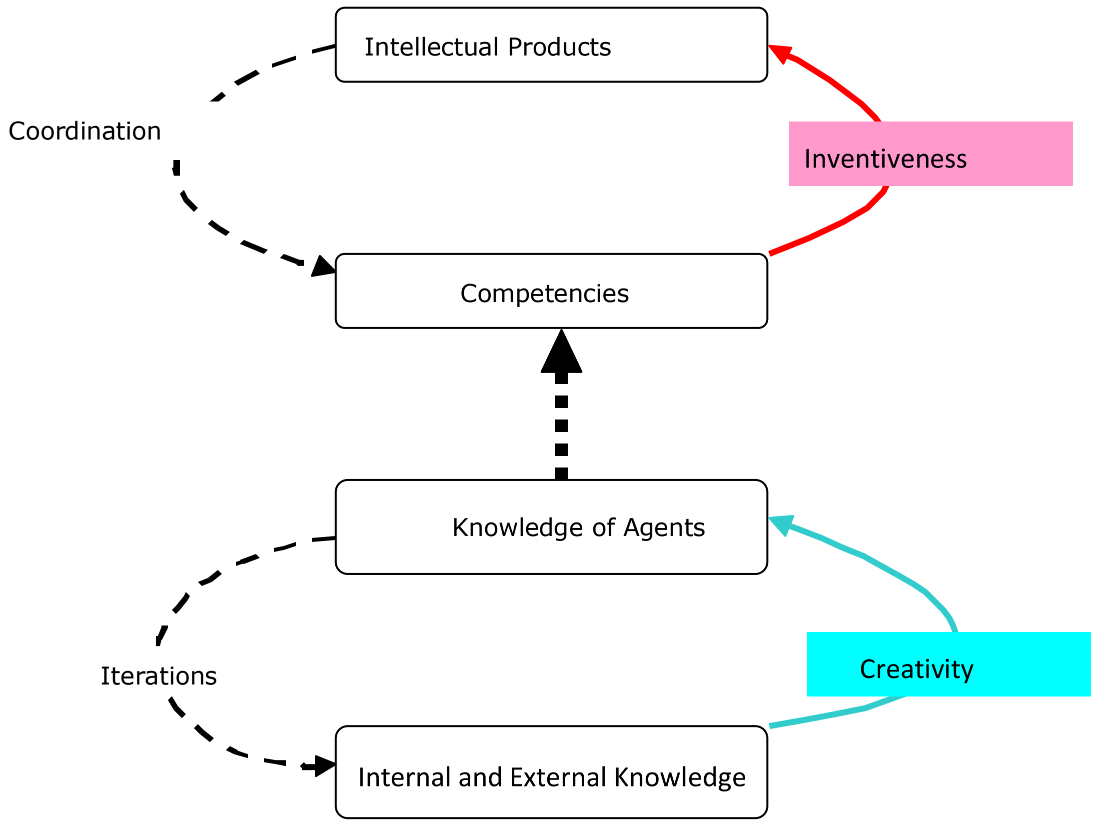
In practice, an innovation encompasses two distinct but interrelated aspects: the first focuses on tangible products and reflects activities from idea to product, the second focuses on intellectual activity within the company to create knowledge or inventive practice. Depending on these aspects, the tools used for innovation differ: in the first case, it is structural and logistic support for innovation, in the second, it is an explication of the will of the company's management to develop a policy that can support inventive activity and ensure the development of the company's intellectual capital.

In any case, these processes are based on the creativity of acting agents within the company with knowledge that are stimulated by the strategy of creating and using the company's intellectual capital, leading to the creation of new technological trajectories. An integrated systems approach to knowledge management should ensure a transition from the company's ability to manage its knowledge capital to the company's ability to use this knowledge. The process of transforming the individual competencies of existing innovation agents within a company into a portfolio of innovative products or services in accordance with the company's strategy can be called a knowledge value chain.

The scientific literature uses the concept of intangible capital or intangible assets of a company to denote all intangible elements, the possession of which can bring economic benefits to the company. This concept covers both non-formalized aspects of intellectual property of knowledge agents that cannot be appropriated by a company, and intangible assets that are materialized and expressed in an explicit form with the provision of registered intellectual property rights (patent rights, copyrights, etc.). The latter, as a rule, are included in the company's information database as the basis of its intellectual capital.

The ascending process of generating ideas (from knowledge agents to the knowledge system) can be described using the categories of creativity and ingenuity: the first category is associated with the abilities that allow you to generate ideas, the second - with the embodiment of the abilities leading to the creation of intellectual products based on the generated ideas that can be materialized in various ways.

Figure № 1. Bottom Generation Model Outline



Source: developed by the authors of the article.

Considering the multilevel and complex nature of all factors of knowledge generation and their influence on the dynamic formation and development of intellectual capital, it can be argued that traditional methods of mathematical and statistical modeling, as a rule, are not suitable for their analysis. If we take into account the

characteristics of each of these factors, especially their combination, the possibilities of analytical approaches and planning based on them are questionable.
In fact, here we are talking about solving the main conceptual problem of most economic theories - the relationship between the micro and macro levels of the economy, i.e. the emergence of economic orders from the individual behavior of agents. In systemic simulation models, the analysis of the dynamics of individual behavior and the interaction of agents at the micro level includes long causal relationships, multilevel feedbacks, and unforeseen effects, showing how macro parameters of economic orders arise from these dynamics. In this context, the issue of the possibility of experimental confirmation of the reliability of research results based on analytical methods is being addressed, since, as a rule, they have problems with such aspects of experiments as reproducibility and controllability.
For cases when the mutual reaction between micro-behaviors of agents and macro-behaviors of the system is investigated, agent-based modeling is directly applicable.
The second postulate of the system theory is that agent-based modeling makes it possible to connect the dynamic behavior and structure of the system with the properties and behavior of individual agents and **their** interaction.
Here you can trace the behavior of the system to a combination of individual action items and decisions at the agent level, i.e. or to demonstrate how changes at the system level affect the behavior of agents, and vice versa.
An example of an agent-based approach, where the agents are knowledge-intensive companies and organizations, is the SKIN (Simulating Knowledge Dynamics in Innovation Networks) model designed to model knowledge profiles, scientific and research sectors, and innovation networks at various scales [5]. The practical application of the SKIN model to the dynamics of innovation networks in various industries is highlighted in the work "Modeling the dynamics of knowledge in innovation networks" (edited by N. Gilbert, P. Arweiler and A. Pike) [6].
SKIN introduces an agent-based modeling platform with knowledge-based companies as agents seeking to produce new basic or applied knowledge and / or new products and processes through innovation. Agents are in an ever-changing complex social environment where their activities need support, for example, in the market if they are focused on innovation, or in the scientific community if they are trying to publish their research results.
SKIN agents are knowledge-based learning organizations. Each agent has an individual dynamic knowledge profile. In the model, an agent's individual knowledge base is a vector in a multidimensional space that the agent uses as a source and object for his research and innovation. The abstract knowledge profile can be calibrated or augmented with empirical data. Data points are “units of knowledge” (eg core competencies, abilities, codified and tacit knowledge, explicit and tacit knowledge) that are produced, used and available.
Since the flexible architecture of the SKIN platform is created by agents, knowledge and networks, agents in any SKIN application interact at both the knowledge and institutional level. Within the framework of interactions, SKIN agents have access to a large number of strategies and mechanisms, for example, choosing partners, entering into partnerships, initiating knowledge exchange, generating joint knowledge outcomes or distributing rewards for innovation.
Two groups of intersecting problems of the agent-based approach to models of intellectual capital are associated with its potential advantages in analyzing the emergence of economic systems from the individual behavior of agents.
The first is related to the fact that information about agents, their expectations, goals, competencies, strategy, behavior in cooperation, etc., as well as the context of their actions, processes, cultures and institutional frameworks in which they are embedded is determined using qualitative methods, such as interviews with participants, case studies, and analysis of documents or discourses, and are “assigned” by model constructors to each of the agents based on certain formalized procedures. The agent profile, interactions and resulting social structures can also be calibrated using empirical data.
Thus, the entire initial scenario depends on conceptual preferences, used metrics and subjective assessments of the model constructor, who acts as an expert in the theory and practice of intellectual capital management.
As N. Bontis testifies, “there are three problems that we must overcome before the developing theory of intellectual capital became mainstream as a management discipline. First, it has a traditionally bad reputation in the eyes of most practitioners in HR, accounting, finance, and strategy. The situation is slowly changing in some industries and geographic regions, but in general there are huge differences in the quality of work from the point of view of practicing managers. We have no problem understanding this area, but we definitely have difficulty identifying, measuring and using intellectual capital to provide sustainable competitive advantage.
Secondly, we have bad experience with data. For example, human capital analysts often fail to extract meaningful meaning from employee surveys. In addition, we suffer from inconsistencies in the definition of metrics such as full-time equivalence or voluntary turnover. That said, our ability to integrate quantitative models (e.g. VAIC) with qualitative indicators (e.g. survey data) still leaves much to be desired and requires significant re-investment. ”[7]
The second group of difficulties of the agent-based approach is associated with an uncontrolled increase in the

complexity of modeling in the context of an increasing number of agents in the system, especially when it comes to the value attitudes and psychological characteristics of human agents. For example, in the international technology concern Siemens A.G. R&D employs around 43,000 people in 44 countries, including around 14,100 in Germany. With a significant number of agents, human individuals, their properties can be specified only in a stereotyped template code.

In such cases, the best option for the systems approach is system dynamics - a well-known and developed method of computer modeling that is used to analyze complex systems with nonlinear dynamic feedback in order to obtain information and develop policies to improve system performance[8].

The third postulate of systems theory determines that the analysis of intellectual capital will focus on solving two problems: firstly, on identifying the mechanism that supports the role of intellectual capital in the dynamic innovation capabilities of technology companies, and secondly, on determining how the institutional context regulates the relationship between intellectual capital and dynamic innovation capabilities.

For example, in the system dynamic model, several main components (or "funds", in the terminology of system dynamics) can be distinguished: investment and expenditure on R&D, the innovative potential of the knowledge of employees of R&D departments, intangible assets reflecting the dynamic interaction between the company and the external environment, as well as the materialized results of the implementation of technological innovations [9].

Technological innovation is the combined result of two different forms: product innovation and process innovation, which consist of a sequence of actions occurring over a period of time. The research goal of system-dynamic modeling is to study the dynamic flow of material, intellectual and organizational resources throughout the entire process - from investment in R&D to technological innovation based on accumulated knowledge, in the context of product innovation and process innovation [10].

System dynamics is based on the identification of key system variables, the interactions between them, and the study of the effects of these interactions over time. For example, investment feasibility can be considered in a project as a scenario or a set of scenarios that represent the results that are likely to be achieved when making investments in the context of analyzing external and internal factors and the sensitivity of selected indicators to them. If we consider the investment feasibility in the form of a complex cybernetic system, in which the backbone factor is the return of investment funds at a certain level as a result of activities, then the task is to maximize the correspondence of the company's intellectual capital to this goal of its activities.

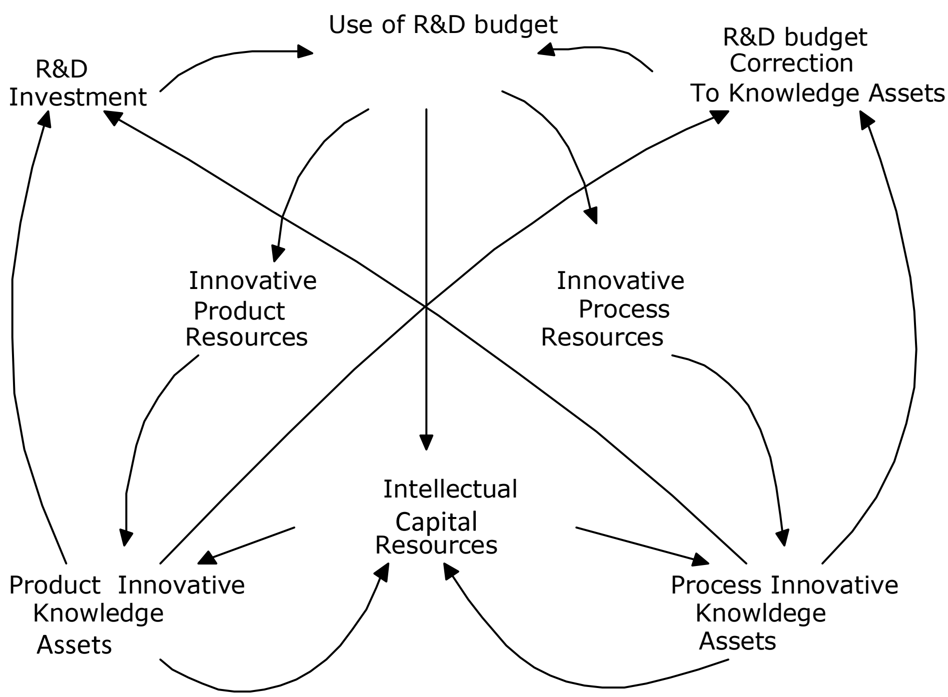


Fig.2:Dynamics of system variables for the implementation of investments in R&D..

Source: Developed by the authors.

The practical task of the system theory is to determine the conditions and level of application of material

(financial, organizational, administrative) and intangible (intellectual resources), under which the effective use of intellectual capital at various levels - companies, regional clusters, industrial sectors, and the national economy - can be ensured.
The application of the system theory seems appropriate in the modern situation, when the danger of the Russian economy lagging behind the advanced countries in a number of key sectors of technological development, such as machine-tool construction, microelectronics or hydrogen energy, has become evident [11].
At the same time, it should be understood that sectors in which Russian industry is significantly inferior in competitiveness to large foreign players, and Russian science is hardly ready for a technological breakthrough, today cannot develop without adaptation to the Industry 4.0 system. In modern scientific literature, it is generally defined as a complex of integrated production facilities, supply chains and service systems based on a number of fundamental and basic technologies.
The transition to Industry 4.0 is based on fundamental technological advances: adaptive robotics, big data analytics and artificial intelligence, modeling, cyber-physical systems (CPS), the industrial Internet, cloud systems, additive manufacturing and virtualization (VR and AR). They are supported or provided by basic cybersecurity technologies, sensors and actuators, radio frequency identifiers (RFID) and real-time positioning systems (RTLS), and mobility systems.
Analysis of the world scientific literature on the problems of Industry 4.0 shows that technological advances and models for implementing strategies can only be ensured with a high level of investment in providing intellectual capital [12]. In other words, the mobilization of intellectual capital is seen as a strategic element underpinning national industrial and economic policies.
Russia's prospects in the development of intellectual capital have so far been characterized by low intensity and lack of consistency, which in fact excludes the achievement of the breakthrough effect that was declared in a number of government documents. In this context, the economy of the Russian Federation needs to apply a systemic integrated approach to managing the creation and accumulation of intellectual capital, which in practice can be implemented, incl. using public-private partnership tools and the formation of multilateral consortia to overcome infrastructure problems and share risks similar to technologically advanced countries, where the coalition approach of various Industry 4.0 development initiatives has proven successful in stimulating public-private cooperation.

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