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Decomposition Model for Intellectual Capital Assessment: Regional Perspective

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ABSTRACT

The relevance of the topic is determined by the growing role of intellectual capital as a key factor in the sustainable development of territorial socio-economic systems under the circumstances of digitalization and increasing interconnection of socio-economic processes. **The purpose** of this article is to develop a modified hierarchical model of intellectual capital reflecting the complex cause-effect relationships between its components and socio-economic indicators. **Methods of the research** include bibliographic analysis, systematization of indicators from regulatory documents, and synthesis of cognitive models. **Scientific novelty** lies in the integration of cognitive activity types into the structure of intellectual capital, including creative and innovative activity as a link between self-development and innovation. **The results of the study** indicate that intellectual capital should be viewed not as an isolated resource, but as a dynamic system capable of shaping development trajectories of territorial socio-economic systems. **Practical significance:** the findings can be used in decision-making processes related to regional development and in assessing the effectiveness of program tools. The model is universally applicable for economic analysis at both meso- and macroeconomic levels. Prospects for further research involve applied testing of the model in specific regions and refinement of the indicator set for different types of territorial socio-economic systems.

Keywords: intellectual capital; socio-economic development; cognitive activity; territorial socio-economic system; ecosystem approach; co-evolution; digital economy

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INTRODUCTION

Domestic and foreign researchers have studied the phenomenon of intellectual capital (IC) relatively recently. The concept of "intellectual capital" was formulated in the late 1960s, and later in the 1990s, it became an independent theoretical field of knowledge. Since that time, it was manifested in economic science, but the growing number of publications on this topic covered primarily the micro-level of the economic system. As to the meso- and macro-levels, such researches explored the specifics of IC comparatively seldom, which is mainly due to the complexity of the object of study and its components. Moreover, its key features become more pronounced in the process of the shift towards the digital economy, because the IC's dynamic nature of interrelations between elements and tacit, indirect impact of some components on others.

Traditionally, intellectual capital is visualised in the post-industrial society as the main source of competitive benefits at the microeconomic level and a key factor of socio-economic development at the meso- and macro-levels. A considerable volume of research was devoted to confirm it. Nevertheless, contemporary science and practice encounter problems of ambiguity in the cause-effect relationship between the IC accumulation and the socio-economic development of entities at the meso- and macro-levels of economic systems. Is the latter process estimated as a natural consequence of the first phenomenon, or is it more appropriate and correct to visualise their complex interconnection and interdependence? This topic is significantly underestimated in the overall volume of publications. Researchers primarily study general directions of mutual influence between IC elements and indicators of socio-economic development of economic entities, ignoring specific quantitative elements. This makes it impossible to justify specific management operations. The abovementioned circumstances have determined the relevance of research of this topic.

IC AND ITS ROLE IN THE DEVELOPMENT OF TERRITORIAL SOCIO-ECONOMIC SYSTEMS

Prior to starting the research of the problem field, it is essential to define the gist and content of the subject: the IC bearer at the meso- and macro-levels of the economy. For this objective, it is recommended to use the generalised term "territorial socio-economic systems" (TSES), meaning a set of socio-economic entities grouped according to territorial criteria at various levels of the economy, together with the links between them and with the territory *per se* [1].

Foreign researchers also present a variety of approaches to interpret this concept, although with a slightly different terminology. For example, one of the research work points out, that any territorial formation combines three interconnected components: a part of a state's territory, the local population, and public authorities, which implement governance within the limits of delegated powers [2].

Another research work defines a socio-economic system enterpreted as a structured multiplicity including subjects (enterprises, entities and communities) and objects (natural environment, technologies and infrastructure) which interact within a specific geographical area: a country, region, or city [3]. Besides, TSES is viewed as a public territorial complex, an aggregate of interrelated forms of human life, which develops on the basis of organised production [4] or as a space-time related combination of socio-economic elements of human life engaged in the process of social reproduction based on geographical division of labour [5].

The given term was chosen in view of such factors as:

- a complicated and interrelated nature of various components of socio-economic development of entities (economy, population, infrastructure, governance);
- administrative (municipal formations, regions) and functional (agglomerations, economic clusters) boundaries;

• the possibility of its use in scientific discourse, which is due to its the systemic nature of interaction between various elements (human capital, infrastructure, innovations).

The traditional view of IC as a factor of economic growth is based on the concept that highly qualified personnel, sophisticated education system, and scientific-research base lay the foundation for a region's economy [6]. However, this approach does not account for the complicated nature of interaction within economic systems, that influences the IC level, which in turn, under the circumstances of globalisation and digitalisation, not only stimulates economic development but is also transformed by it [7].

The reason for this factor can be found within theoretical inquiry in the provisions of the ecosystem approach, which is based on the concept of co-evolution. This concept rests on the allegation that the development of socio-economic systems occurs in interconnection and mutual conditioning, which stems from the complex dynamic interaction of their elements [8–11]. Joint development represents a particular case of co-evolution and occurs in case of conscious intervention in the formation of interconnections among objects of a complex socio-economic system [12].

The evidence for this thesis can be revealed in empirical studies that examine a group of indicators for assessing IC. Simultaneously, a large number of these indicators can be viewed in the context of socio-economic development of regional entities. For instance, foreign scholars apply the Empowered Life Years indicator for assessing sustainable urban development. It is aggregated on the basis of the life expectancy indicator and is supplemented by such additional metrics as health quality, literacy, happiness, and poverty eradication [13]. One can also distinguish the US Cities Sustainable Development Goals Index, developed in 2016. Its assessment methodology is based on the calculation procedure of 100 cities, inolving about 70 per cent of the country's population, [14] and it is used to monitor urban progress achieving the sustainable development goals formulated by the UN. Another important assessment instrument is the integral City Prosperity Index, developed by UN-Habitat,[1] determined by involved components of productivity, life quality, infrastructure development, environmental sustainability, and social equity. Human Development Index[2] is of great importance too: many researchers interpret it as an integral indicator of the human capital of regional systems. Its calculation envisages the assessment of longevity, education level, and standard of living.

All the mentioned above indicators, on the one hand, present the sustainable socio-economic development of TSES, and on the other hand, indicate a growing satisfaction of population with living conditions in a given territory and the formation of a sense of commitment.

The Knowledge Economy Index, developed by a World Bank group in 2004 makes up the composition of four groups of indices related to economic and institutional regimes, education, innovation, as well as information and communication technologies.[3]

V. Yu. Ivanova recommends using a decomposition of regional IC assessment indicators within eight groups, which explicitly characterise the socio-economic development of the region [15]. The research work by I.F. Zhukovskaya and I.A. Orlov involves the assessment of investment attractiveness of a regional socio-economic system, foreign and domestic tourism, the number of business incubators, etc. [7]. D.I. Mashkina emphasises that the regional IC market has a specific internal structure, including such interconnected elements as the state, investment and infrastructure provision, knowledge, and intellectual property [16].

It is also worth noting the analysis by A.A. Chub and P. Yu. Makarov with a modified

[1] URL: https://unhabitat.org/sites/default/files/download-manager-files/State%20of%20the%20World%20Cities%2020122013.pdf

[2] URL: https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

[3] URL: https://estadisticas.pr/files/BibliotecaVirtual/estadisticas/biblioteca/BM/BM_KAM_2008.pdf

version of "intellectual capital monitor" model by D.J. Andriessen and C.D. Stam [17], accounting for such elements as expenditures on technological innovations, investment in fixed capital, and GRP per capita [18].

A.A. Maltseva considers IC an important resource that ensures the socio-economic development and competitive advantages of a territory [19], as it is the main performance indicator, transforming strategic priorities. The primary condition here is the developed social infrastructure of the region. The research work of I.N. Alexandrov and M. Yu. Fedorova describes the main objective of TSES development not as the growth in budget revenues, corporate profits, or gross regional product, but as a better quality of life, dependent on a number of factors including education, healthcare, culture, etc. [20]. V.E. Saktoev with co-authors recommend using a composite regional index (RI) of IC for assessing intellectual capital, determined by the method of weighted arithmetic average of intermediate indices: social well-being, scientific potential, and information-communication component [21]. L.S. Shakhovskaya and A. Yu. Kiryanova advise evaluating the sphere of science and education, the state of regional infrastructure, and investment in fixed capital [22]. In the same contest, T.V. Smetanina and O.V. Zhikina, spotlight the increase in gross domestic product, growth in investment in science, higher education, healthcare, culture and lower level of "brain drain" [23]. O.I. Rudaeva emphasises the requirement to determine the cause-and-effect relationship between IC indicators and the level of prosperity in a country, or region, in view that investment may be conditioned by economic growth, and not vice versa [24]. The scholar also suggests moving away from classical models where intellectual capital is considered a static variable. Instead, methods based on non-linear models and cognitive analysis become relevant, allowing for the consideration of feedback and the influence of multiple factors.

T.V. Ostashchenko and I.N. Dubina believe that the growing level of regional IC reinforces economic development indicators, which signifies the so-called "delayed effects" [25].

Thus, the contemporary research is changing the concept of IC as an autonomous factor: both IC and socio-economic development are now visualised as interconnected elements of a single system, where interaction has a co-evolutionary nature. This position is of important practical significance: the management of IC cannot be limited exclusively to its accumulation. This must account for measures for the sustainable economic development of the region, creation a favourable environment for efficient use of accumulated knowledge and skills [25, 26].

TARGET INDICATORS OF THE MODEL FOR ASSESSING IC OF TERRITORIAL SOCIO-ECONOMIC SYSTEM

Analysing a few domestic and foreign studies on the AI of TSES has led to the conclusion that the overwhelming majority of authors decompose it into three components: human, organisational, and relational, which are subsequently assessed by means of a combination of development indicators. However, the key problem of this approach is that such models do not account for the dynamic nature and complex, many-ways mutual influence of IC elements and socio-economic development indicators. Besides, a separate attention deserves the problem of lack of accounting for the normative component in regulating the strategic development of regional entities. The selection of assessment indicators should be carried out based on the data formulated at the macro- and meso-levels of economic systems. Thus, the combination of a programme-target approach with theoretical stakeholder's perspectives enables developing a fundamentally new model for assessing the IC of a TSES, the distinctive features of which will be the following:

- accounting for the dynamic interrelationship between components of intellectual capital and indicators of socio-economic development;
- accounting for the impact of implicit factors, whose influence on the dynamics of indicators is covert and indirect;

• reflecting the requirements of stakeholders, among the key ones become the state and the population of the TSES.

The proposed approach was tested on the basis of Presidential Decree No. 309 of 07.05.2024 "On the National Development Goals of the Russian Federation for the Period until 2030 and beyond to 2036".[4] From all target indicators in the given document, the *Table* presents those, which achievement reflects the dynamics of IC development and the general directions of socio-economic development of the region (or territory).

[4] URL: http://kremlin.ru/events/president/news/73986

THE IC DECOMPOSITION MODEL OF A TERRITORIAL SOCIO-ECONOMIC SYSTEM BASED ON ASPECTS AND INDICATORS OF SOCIO-ECONOMIC DEVELOPMENT

The presented set of indicators can be further visualised as a hierarchical model, based on another model developed for the microeconomic level [27]. However, it is worth noting that in this

Table

Groups of Target Indicators in the Model for Assessing the Intellectual Capital of a Territorial Socio-Economic System

Indicators of IC Development	Indicators of Socio-Economic Development
2b) Increase in life expectancy to 78 years by 2030 and to 81 years by 2036, including an accelerated growth in healthy life expectancy indicators. 2g) By 2036, reduction of the differentiation in life expectancy indicators by at least 25 per cent compared to the level of 2023. 2i) By 2030, create and launch a digital platform promoting the formation, maintenance, and preservation of human health throughout life, based on the principle of data-driven management. 4a) Improvement in the quality of the living environment in core settlements by 30 per cent by 2030 and by 60 per cent by 2036. 6zh) By 2030, entry of the Russian Federation into the top 25 countries in the world in terms of robot density. 6z) By 2030, involvement of at least 40 per cent of medium and large enterprises in basic non-resource sectors of the economy and 100 per cent of state and municipal social sector entities in projects aimed at increasing labour productivity. 6i) By 2030, creation of an effective system for training, professional retraining, and advanced training of personnel for priority economic sectors, based on forecasted demand. 6k) By 2030, creation of conditions for the simultaneous acquisition of several qualifications by at least 30 per cent of students within vocational education. 6L) By 2030, creation of institutional conditions for continuous professional development of working citizens, incl. acquiring new professions and improving qualifications. 6c) Formation of a network of sustainable partnerships with foreign states and creation of the necessary infrastructure for foreign economic activity, technological and industrial cooperation, and development of new markets. 6f) Increase in the share of creative industries in the economy. 7a) Ensuring technological independence and forming new markets in areas such as bioeconomy, citizen health preservation, food security, unmanned aerial systems, production and automation equipment, transport mobility (including autonomous vehicles), data economy and digital transformation, artificial intelligence, new materials and chemistry, advanced space technologies and services, new energy technologies (including nuclear)	2k) Reduction of the poverty level to below 7 per cent by 2030 and below 5 per cent by 2036, incl. among large families to 12 per cent by 2030 and 8 per cent by 2036. 2-l) Reduction of the Gini coefficient (the index of income concentration) to 0.37 by 2030 and to 0.33 by 2036. 6a) Ensuring a national GDP growth rate above the world average and achieving 4th place in the world no later than 2030 in terms of GDP volume calculated by purchasing power parity, including through labour productivity growth, while maintaining macroeconomic stability, low unemployment, and reducing structural unemployment. 6g) Ensuring sustainable growth of population income and pension provision levels not lower than the inflation rate.

Indicators of IC Development	Indicators of Socio-Economic Development
7v) By 2030, ensuring the entry of the Russian Federation into the top 10 countries in the world in terms of the volume of scientific R&D. 7g) By 2030, increase in domestic expenditure on R&D to at least 2 per cent of GDP, including by means of at least a doubled of private business investment for these purposes. 7d) By 2030, increase in the share of domestic high-tech goods and services created on the basis of proprietary development lines by one and a half times compared to the 2023 level in the total consumption of such goods and services in the Russian Federation. 8a) By 2030, achieving digital maturity in state and municipal governance, key economic sectors and the social sphere, including healthcare and education, implying the automation of most transactions within unified sectoral digital platforms and a data-driven management model, considering the accelerated implementation of big data processing, machine learning, and artificial intelligence technologies. 8b) Formation of a data market, its active involvement in economic circulation, storage, exchange, and data protection. 8zh) By 2030, increase to 99 per cent of the share of providing socially significant state and municipal services in electronic form, including introduction of a decision support system within the framework of at least 100 mass socially significant state services in electronic form proactively or upon direct applicants request through the introduction of a unified digital platform in the activities of state authorities. 8i) By 2030, ensuring an increase in the level of citizen satisfaction with the quality of work of state and municipal employees and workers of social sector institutions by at least 50 per cent. 8L) Ensuring network sovereignty and information security on the Internet	6м) By 2036, reduction to no more, than twofold of the gap in budgetary provision levels between the 10 most affluent and the 10 least affluent subjects of the Russian Federation (taking into account financial support from the federal budget in the form of targeted interbudgetary transfers). 6u) By 2030 increase in the volume of transportation through international transport corridors by at least one and a half times compared to the 2021 level by raising global competitiveness of routes

Source: compiled by the author.

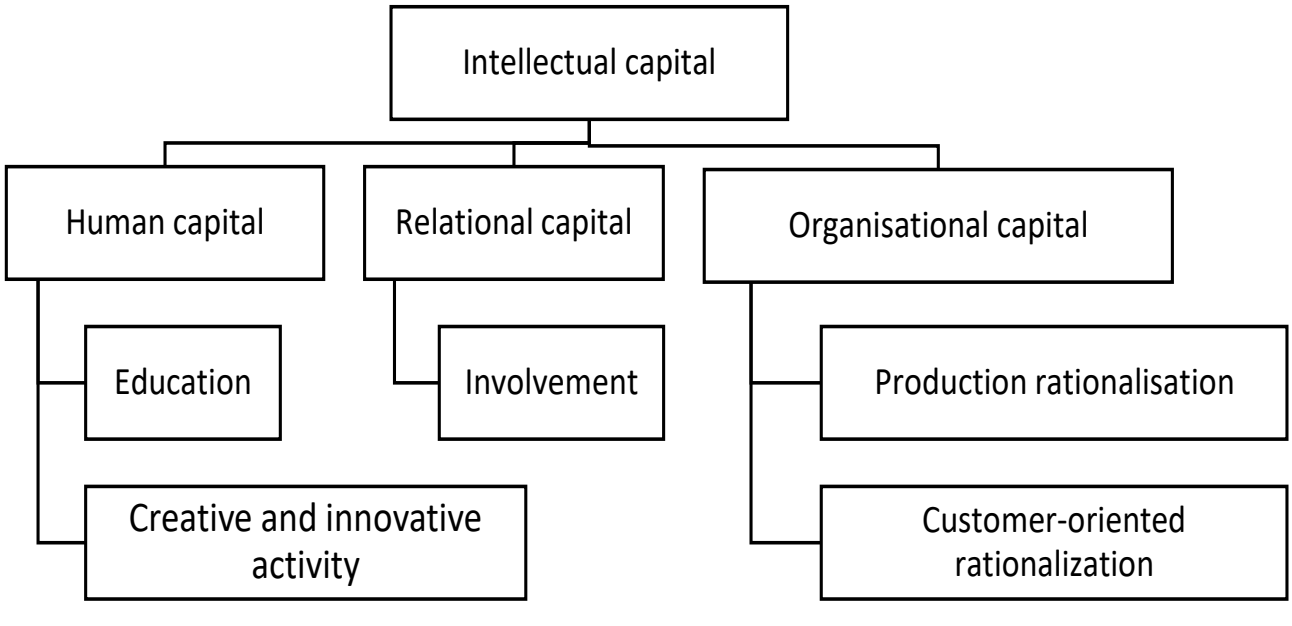
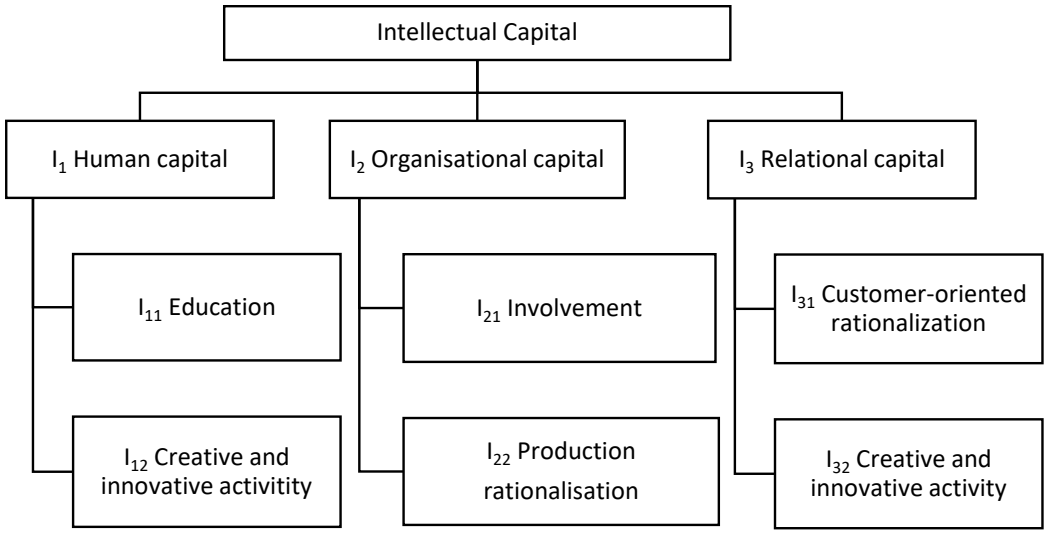
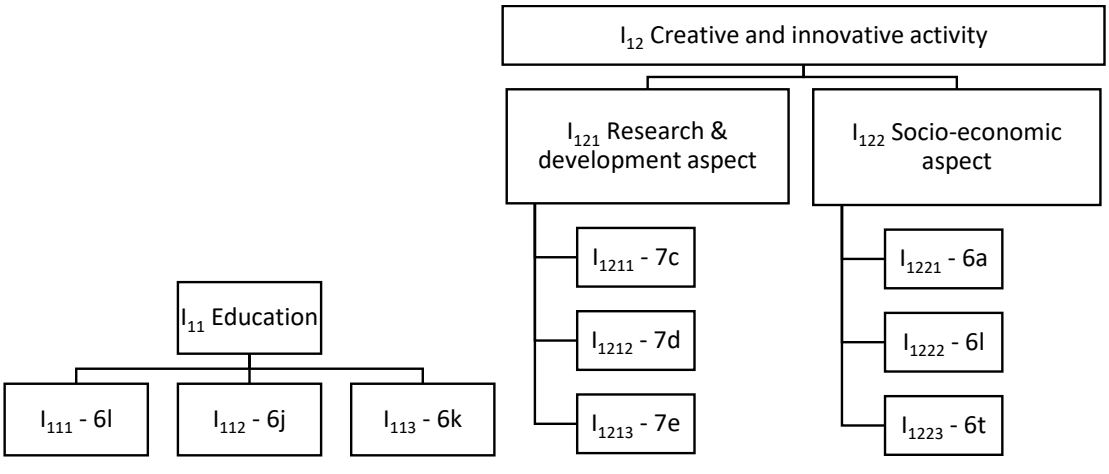


Fig. 1. **Decomposition of the Intellectual Capital of a Territorial Socio-Economic System, in View of the Integration of Cognitive Activity Types "Self-Improvement" and "Innovation Activity"**

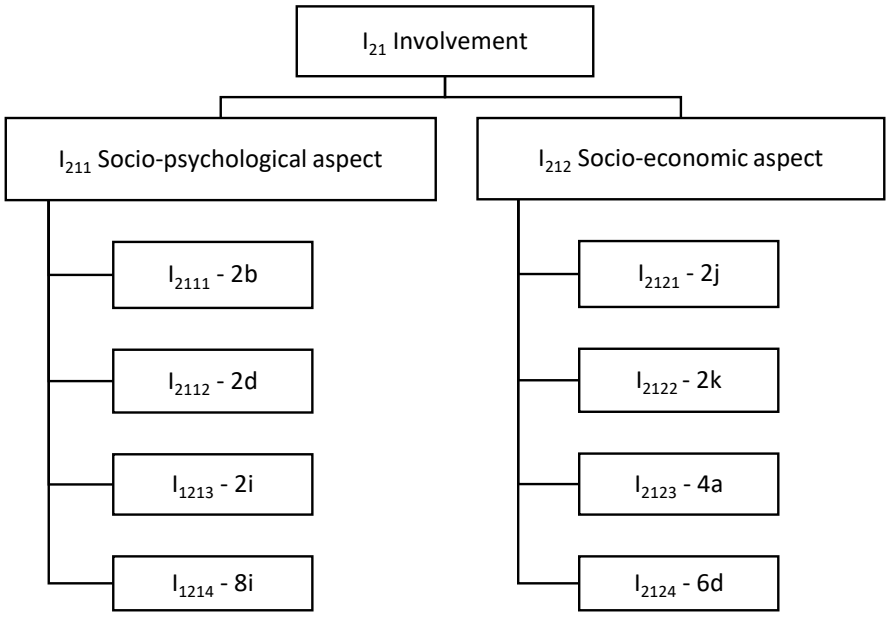
Source: compiled by the author.



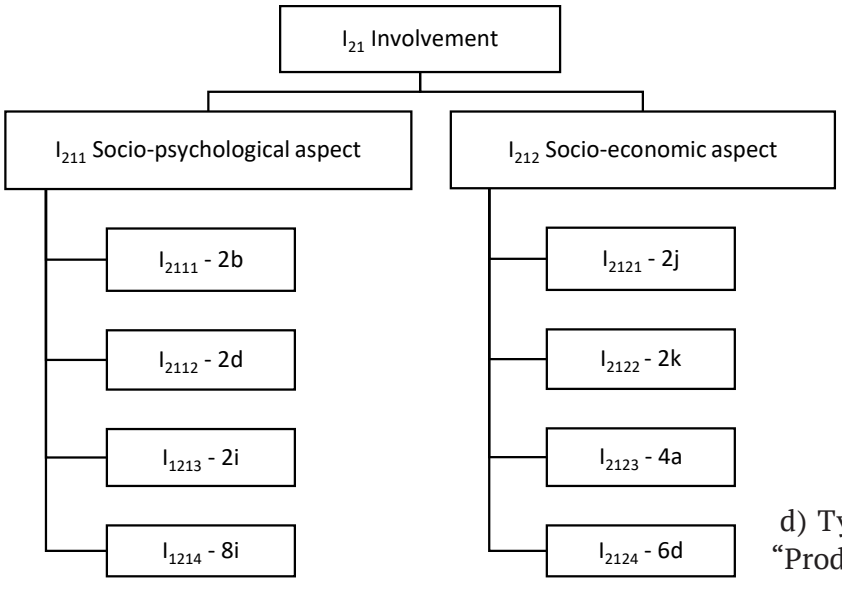
a) The Top-three Levels of the Model



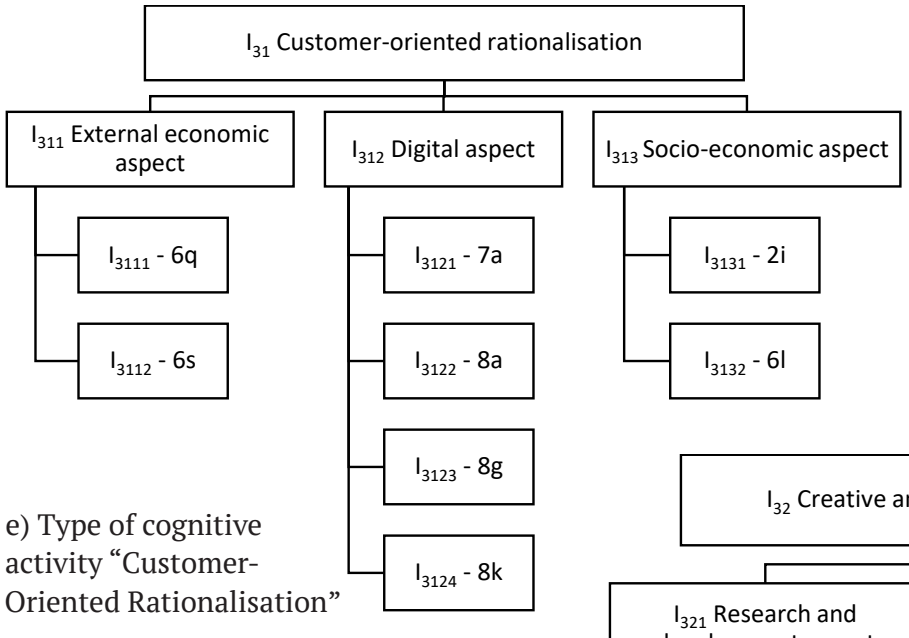
b) Types of cognitive activity "Education" and "Creative and Innovative Activity"



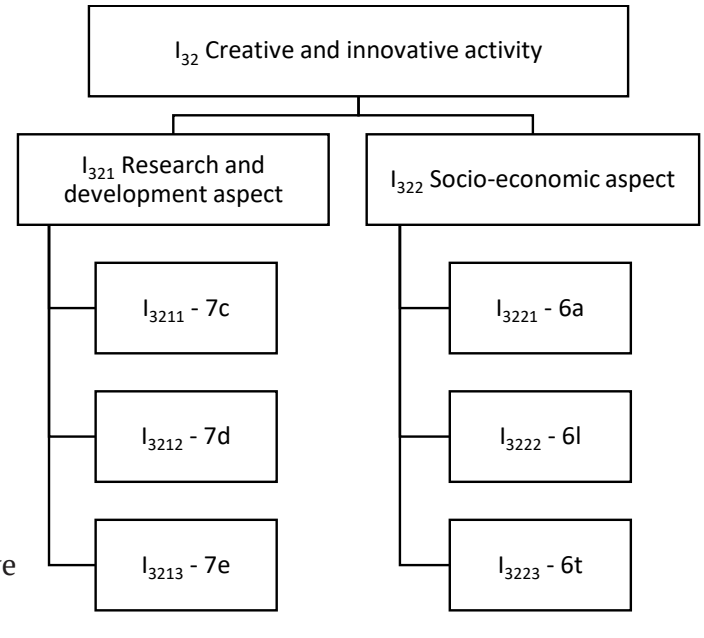
c) Type of cognitive activity "Engagement"



d) Type of cognitive activity "Production rationalisation"



e) Type of cognitive activity "Customer-Oriented Rationalisation"



f) Type of cognitive activity "Creative and Innovative Activity"

Fig. 2. **Hierarchical Model of Indicators for the Development of Intellectual Capital in a Territorial Socio-Economic System**

Source: compiled by the author.

structure, self-improvement is a type of cognitive activity, which occurs exclusively at the level of each individual and focused on setting fundamentally new strategic objectives at the level of separate individuals. The applicability of such approach at the regional level is still an open question, since in this case the formation of new strategic directions is expressed most often through innovative development, making it close to another form of cognitive activity, namely, innovation. In this regard, it seems to be worth enlarging the structure of IC for regions by integrating self-improvement and innovation within a single type of cognitive activity (*Fig. 1*).

The key components in the classical model of IC at the microeconomic level are human capital (knowledge contributed by personnel to the entity); organisational capital (knowledge available in the entity), and relational capital (knowledge generated by the entity in the context of its interaction with the external environment). At the meso- and macro-levels, the content of these concepts keeps changing. A human capital of regions is the population with abilities and skills used in economic activity. The organisational capital is distinguished by the level of development of modern, including digital technologies in the region's infrastructure. The relational capital is defined as the combination of economic ties with external stakeholders, including business partners and the state.

Further possibilities to specify the hierarchical structure imply correlating various capacities for cognitive activity, accomplished at the level of regional entities, with specific indicators of socio-economic development stipulated in strategic development programme documents. It is worth pointing out, that decomposition of IC components is of universal nature and the specific set of lower-level indicators in the hierarchical model is established in the list of those aspects regulated by the relevant programme document. The given research work chose The Presidential Decree No. 309 dated 07.05.2024 as an example of its applicability to entities at various levels of socio-economic systems.

The results of decomposition are illustrated in *Fig 2*.

Based on the data presented in the figures below are the following conclusions:

1. In general, the plurality of indicators is distributed evenly across types of cognitive activity, except its simplest type: "education". It corresponds to only three IC assessment indicators, and therefore, there is no need to identify intermediate aspects.
2. As creative-innovative activity is a type of cognitive activity aimed at building simultaneously human and relational capital, the set of indicators responsible for the implementation of activity are duplicated for each of the cited components.
3. IC indicators can be both qualitative and quantitative. However, the latter are often determined not as concrete values, but as a certain dynamic trend: for instance, "Increase in the total birth rate to 1.6 by 2030". This complicates the estimation of forecast values within the fulfilment of strategic programme activities. The specific nature of qualitative indicators is determined by the fact that they often take the form of a Boolean variable, for example: "By 2030, it is envisaged to create an efficient system for training, professional retraining, and advanced training of personnel in priority economic sectors based on forecasted demand". Concurrently, they can be evaluated in accordance with the scale with possible response options: 'very high probability', 'high probability', 'medium probability', 'low probability', and 'very low probability'.
4. As to other types of cognitive activity, the large number of lower-level IC indicators of assessment requires identifying intermediate aspects, and notably, one of them is, by and large, the socio-economic aspect.
5. The given set of indicators illustrates the interests of key TSES stakeholders, which becomes a fundamental principle of the programme-target approach to strategic planning for the development of such subjects.
6. The complicated nature of meso- and macro-level economic systems predetermines

the requirement of accounting for factors, which make a hidden, mediated impact on the processes of socio-economic development. The proposed model allows for considering these factors by means of methods and tools of fuzzy logic.

Therefore, in conclusion it is notable, that the decomposition model for IC assessment initially developed at the micro-level is universal and can be used at the meso- and macroeconomic levels.

CONCLUSIONS

1. The presented hierarchical model allows for evaluating the current level of intellectual capital of regional economic entities, in view of achieved levels of socio-economic development, as well as forecasting the dynamics of these interrelated indicators.
2. A hallmark feature of the presented model is the capability to account for the complicated cause-and-effect relationship between IC elements at various hierarchical levels and its socio-economic development.
3. In perspective, the use of the given model will allow for the assessment of the efficiency of programme activities, and further research in this direction envisages its testing regarding some specific entity at the meso-level of the economic system.

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