

Measuring a comprehensive model of intellectual capital flows

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Abstract:

Aim: The goal of the article is to understand the place, role and importance of intellectual capital in the development of society and (above all) answering the question of what and why causes the observed changes in its levels.

Design/Research method: The paper presents the concept of analysis of intellectual capital flows and frame of methodology for construction a comprehensive model of the intellectual capital flows and its influence on society.

Conclusions/Findings: Authors of the article suggest that intellectual capital flow is more critical than intellectual capital in its comprehensive analysis.

Originality/Value of the article: Intellectual capital was expressed as a vector - the basic element of the flow - and the components of the vector describes various elements of intellectual capital while the flow itself should be a multidimensional flow.

Keywords: intellectual capital flow, vector of intellectual capital flow, grey theory.

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1. Introduction

Intellectual capital, although difficult to define, is a relatively intuitive concept (Niemczyk 2016; Osińska 2014). When a student goes to school, there is obviously certain amount of the broadly understood intellectual capital flowing between the school and the student. If the school fulfils its purpose, it can be assumed that more intellectual capital flows from the school to the student rather than otherwise, and that the character of such flow is quite homogeneous. Note that in this case intellectual capital is what we usually call knowledge.

When people move to major urban centers, they bring their individual intellectual capital along, and thus the cities become the areas of the capital's concentration. In this case, intellectual capital is obviously made up of knowledge, although it also comprises a number of other elements resulting from interpersonal relationships, organizational structures, etc.

When a standardization organization certifies a company, it can be assumed that the capital flows which occur between the company and the organization are of a rather heterogeneous kind, and different for both entities. It can be safely assumed that the standardization organization transfers certain scope of knowledge, the so-called optimal knowledge, and receives in return a confirmation of this optimality and an indication of exceptions to its application.

Considering a university or a research institute, it seems that they are mainly sources of intellectual capital (quite easily identified with knowledge, even though constituting other elements like culture, relationships, or individually developed personality traits). In addition, students and university employees also contribute to the university's intellectual capital. In other words, it seems that some organizations (or organizational units) are primarily “manufacturers” of intellectual capital, while others are mainly its “consumers”. With high probability, there is no organization that is solely the “manufacturer” of intellectual capital. Nor are there organizations which are solely the “consumers” of intellectual capital.

These observations lead to the conclusion that the basic characteristic of intellectual capital is its flow between “consumers” and “producers”. However, no element of the broadly understood social structure is solely a “consumer” or “producer” and, to some extent, all of them perform both of these roles.

Analysis of intellectual capital flows leads to the goal of understanding of the place, role

and importance of intellectual capital in the development of society and, above all, to answering the question “what” and “why” causes the observed changes in the level of intellectual capital. The first step on this way, as well as the main goal of the article, is to understand the necessity to create a comprehensive model for all the possible capital flows.

2. Assumptions of the model of intellectual capital flow

The proposed model will be used in the analysis of existing flows of intellectual capital. It is assumed that the model should allow to comprehensively model intellectual capital flows in the entire human environment. The implications of the assumption are profound and have several cognitive aspects that, generally speaking, lead to the possibility of manipulation of the observed flows, although this is not the aim of this project.

General assumptions for the model of intellectual capital flow:

- 1) The model is inherently an interdisciplinary one. It covers a range of scientific disciplines such as: economics, management, applied computer sciences, mathematical methods (operations research), econometrics, statistics and system analysis.
- 2) Although our intention is primarily to create a comprehensive model for all the possible capital flows, additional detailed models of intellectual capital flows should be verified (e.g. using NUTS 2 and NUTS 3 European classification).
- 3) Possible detailed solutions should allow for forecasting and planning of social development and, in particular, should find a direct application in the analysis of regional development.

It should be assumed in advance that the planned partial results received during the research should concern, among others, the following aspects:

- construction of a model of intellectual capital flows between different elements, at different levels,
- methodology for building a multi-dimensional map of intellectual capital resources for selected element of the social structure (region, companies, units, etc.),
- determining factors in the development of intellectual capital for particular element of social structure. For example, it can facilitate development of a map of the Polish national and regional distribution of intellectual capital at NUTS 2 and NUTS 3 levels,

- definition of scenarios/profiles of the intellectual capital development in selected element of the social structure
- recommendations for the development of intellectual capital, with focus on both an element of the social structure, and its entirety.

3. Methodology for construction of the model of intellectual capital flows

There is no single existing research methodology allowing the study of such complex social phenomena, which calls for a systematic approach. It is thus necessary for the authors to develop own research methodology that would primarily combine approaches from system analysis and adaptation of specific partial solutions of econometrics and statistics, including data mining, analysis of computer networks, and fuzzy, rough and grey set theory.

In particular, the following elements of the proposed research methodology should be mentioned:

- Analysis of scientific literature and intellectual capital evaluation studies in relation to different elements of the social structure,
- Analysis of selected case studies,
- Analysis and econometric and forecasting models for intellectual capital for objects at various levels,
- Analysis of user characteristics data from professional and business networking communities (e.g. LinkedIn GoldenLine, etc.),
- Analysis of the effects of intellectual capital productivity during a period in the past by measuring the value of intellectual capital for given element of social structure,
- Analysis of the structure of capital flows and relationships with the use of the so-called theories of belonging (fuzzy, possibilistic and gray),
- Finally, creating a matrix of intellectual capital flows.

We expect to develop a model of intellectual capital flows, which, relatively speaking, is an analogue of Ackoff's flow matrix in relation to intellectual capital. The model of intellectual capital flows should therefore include conceptual and application levels. On the conceptual level methodological foundations of the measurement of intellectual capital should be considered and,

consequently, the flow described. As part of the application level, it must be demonstrated that the developed model suitably represents actual intellectual capital flows, the consequences of which, in turn, allow the dynamic description of the social system including intellectual capital.

4. Conceptual layer

The conceptual part, as a starting point, assumes the view that intellectual capital is the primary resource and an essential socio-economic development factor. Edvinsson and Malone (1997) indicate that in the knowledge economy, the value of countries, regions, organizations and individual units is directly related to their knowledge and intellectual capital. Their authors, by intellectual capital understand "the knowledge that can be converted into value". This capital is a somewhat eclectic category that includes an array of resources involved in the creation, development and deployment of knowledge. It involves a set of components like human capital along with its "instrumentation", which is essential to converting the accumulated knowledge, skills and competencies into concrete economic results. These include: social capital (representing mental support for the human capital), structural capital (i.e. material, infrastructure, organizational and technological support) and relationship capital (demonstrating the ability to include into a network of cooperation and exchange of knowledge between themselves and the external environment) (Schiuma, Lerro 2008). The conclusions drawn from the theoretical considerations and observation of business practice suggest that consistency and synergy resulting from all of the above components lays lasting foundations for development and is the key element for building a competitive advantage in the ever-evolving paradigm of management. In light of the recently promoted concept of endogenous development it is also one of the most important causal factors that determine whether a territorial and social system obtains the ability to develop, or continues in stagnation and backwardness.

Intellectual capital can be measurable, and either directly or indirectly observable. For example, in the case of intellectual capital of companies, the following equation is true: intellectual capital = intangible resources/assets (excluding intangible and legal values). For other entities (e.g. people, public administration, etc.) there is no simple relationship, because transport infrastructure, schools, businesses, nonprofit organizations, museums, theaters etc. can be

expressed in a variety of categories: cash (buildings, machinery and equipment, income, infrastructure construction costs), GDP rates, tax rates, public subsidies, etc. Warschat et al. (1999) distinguish, for example, components of intellectual capital in the industrial sector, as presented in Table 1. Similar definition of intellectual capital can also be found e.g. in the work of Stewart (1997, 2001) and Sveiby (1997) and in many subsequent works.

Table 1 The components of intellectual capital in the industrial sector

Human capital	Organizational capital	Market capital	Innovation capital
- competence - attitudes and behavior - leadership and development	- processes - infrastructure - organizational culture - management process	- relations with customers - relations with suppliers - market competence - other relations	- streamlining processes - products and services - technologies

Source: Warschat et al. (1999).

Concerning regions (Table 2 and 3), it should be noted that their intellectual capital is defined analogously to the intellectual capital in the industrial sector. The biggest practical input in the field of transferring the concept of intellectual capital measurement from the field of business activity to the level of a region or country is attributed to Bontis (2004). In his view, "the intellectual capital of the country includes the hidden values of the country's citizens, businesses, institutions, communities and regions that are current and potential sources for wealth generation. These hidden values are the basis for the improvement of future social welfare" (Bontis 2004), its constituents are, by analogy to the Skandia Navigator (cf. Edvinsson, Malone 2001): human capital, processes, capital market and capital development (cf. Bontis 2004; Stähle, Pöyhönen 2005; Pasher, Shachar 2005; Węziak 2007; Lin, Edvinsson 2008). Human capital and market capital are components of intellectual capital in both the industrial sector, as well as the intellectual capital of the region. Moreover, organizational capital in the industrial sector corresponds to procedural capital in the regions, and innovation capital (manufacturing sector) corresponds to development capital (regions).

The concept of intellectual capital flows calls for a standardized definition of the "intellectual capital". It is thus expected that intellectual capital expressed as a vector will be the basic element of the flow, and the components of the vector will describe various elements of intellectual capital, while the flow itself will be a multidimensional flow.

Table 2. The components of intellectual capital in the region

Human capital	Social capital	Capital development	Structural capital
<ul style="list-style-type: none"> - focus on entrepreneurship - civilisational competence - satisfaction - focus on personal development 	<ul style="list-style-type: none"> - organization - trust - neighborhood - friends, - quality of institutions 	<ul style="list-style-type: none"> - research and development activity - investments - population migration 	<ul style="list-style-type: none"> - health - infrastructure - transport

Source: Węziak (2008).

Table 3. Components of intellectual capital in the country and examples of indicators characterizing them

Human capital	Process capital	Market capital	Capital Renewal
<ul style="list-style-type: none"> - skilled labor - employee training - literacy Rate - higher education enrollment - pupil-teacher ratio - internet subscribers - public expenditure on education 	<ul style="list-style-type: none"> - business competition environment - government efficiency - intellectual property rights protection - capital availability - computers in use per capita - convenience of establishing new firms - mobile phone subscribers 	<ul style="list-style-type: none"> - corporate tax encouragement - cross-border venture - openness of culture - globalization - transparency - image of country - exports of goods 	<ul style="list-style-type: none"> - business R&D spending on basic research - R&D spending/GDP - R&D researchers - cooperation between universities and enterprises - scientific articles - patents per capita (USPTO + EPO)

Source: Authors' own elaboration.

Intellectual capital can also be hidden character size and unobservable. These attributes are unobservable attributes of inhabitants of the region, enterprises and institutions, organizations, communities and administrative units that are current and potential sources of social welfare and economic development.

In addition, consideration must be given to other occurring factors which, although do not constitute intellectual capital per se, may indicate potential existence of it. In a region, for example, such factors are its all available resources (mainly intangible, but also material) giving the region a relative advantage over other regions. These factors, when cumulated and co-occurring, can bring certain benefits in the future and significantly affect the flow of intellectual capital.

It is therefore necessary to examine all the possible concepts of intellectual capital, its measurement methods and reduction of all redundant concepts and values to the ones necessary

at particular level of analysis (Dominiak et al. 2011, 2013).

It is still necessary to develop the concept of human intellectual capital and its model. Thus it seems particularly important to define the so-called relational capital, which should measure all kinds of human relationships, particularly the relationships with other people, and determining how the human capital influences particular person. Assuming the creation of such comprehensive model is successful, relevant definitions of intellectual capital must be specified, along with entities possessing it, from man to more complex units. Among them are: (a) businesses, social organizations, etc., including multinationals or cross-border companies, (b) administrative units at various levels, i.e. appropriate regions, (c) countries. The prerequisite is that all these objects remain in relationships that can be systematically analysed. It is especially difficult because of the existence of a large number of unverified data that not only fail to improve the intellectual capital model, but can also be a major source of disinformation.

Development of human intellectual capital model and its flow is also necessary to determine the intellectual capital of enterprises, regions and countries due to the fact that the flowing human intellectual capital is knowledge. This knowledge can be used to create structural or relational capital that is somehow derived from this knowledge. Knowledge that is not transferred is useless, niche, or hidden. It can be assumed that regions with better dynamics of intellectual capital flows will end up developing faster, or becoming more prosperous in economic terms. Analysis of business portals in terms of profiles of different people will effectively show what influences the growth of this dynamic.

The fundamental problem concerning the analysis of the impact of intellectual capital on development processes is connected with its multidimensional and multi-level character—its resources reside in different functions, structures and technologies, which are deposited at different levels of the system (residents, organizations, regions, country). Pro-development impact of intellectual capital indicates that the development of the resources of this capital should be more widely considered in the proposed territorial development strategies. Particular attention should be given to these dimensions which have a stimulating effect on changes in GDP per capita (ready to lifelong learning, entrepreneurship, inventiveness, and implementation of innovative solutions to business practice, general attractiveness of land for internal and external stakeholders). The impact of intellectual capital on the course and dynamics of development processes is happens primarily by shaping the attitudes and behaviour of residents. This aspect

(incidentally overlooked in quantitative analyses) emphasizes the need for the adoption of subjectivity in the development scenarios of the capital. It is also necessary to remember that compatibility with traditional, basic factors and conditions of development is an indispensable condition for benefiting from the synergies of intellectual capital. Qualitative factors stimulating activity and efficiency become activated when basic parameters of management are secured.

Another aspect that requires attention is the analysis of intellectual capital in computer networks (including the Internet) and other communication techniques (Social Networks and Social Media). The Internet provides a repository of knowledge, but it serves as a platform for exchange of intellectual capital and other intangible assets. Problematic here is resource credibility and virtuality of some entities. What we want to propose here is a systematic approach based on the concept of the so-called “Grey Knowledge”. Grey systems theory is one of the newest theories in the field of artificial intelligence and starts from a definition stipulated in the control theory in which considered an object was black when nobody knows anything about its inner structure and white when this structure was completely known. We assume that the structure and participants of intellectual capital flows implemented through computer networks don't allow unambiguous determination. Therefore, a grey object is that particular entity whose structure is just partially known (Liu, Lin 2010). By using grey theory, we expect to extract and bring some new knowledge about intellectual capital (process and phenomenon). Along with grey relational analysis and clustering, we expect to bring some new knowledge regarding intellectual capital in a given community. We particularly believe that Online Social Networks (OSN's) more or less merged with Social Media “form online communities among people with common interest, activities, backgrounds, and/or friendships. Most OSN's are web-based and allow users to upload profiles (text, images, and videos) and interact with others in numerous ways” (Schneider et al. 2009). The nature of the relationship between elements, from the IC point of view, is dualistic: generative and non-generative. While the generative relationships are due to the interactions among different elements of a system, the non-generative are represented by the inner characteristics of these elements (Forrest 2013; Delcea 2014). Dualism of this approach with regard to the system of knowledge (intellectual capital) makes the amount of knowledge extracted from the system limited and thus considered “gray”. Adding the human element, with its needs closely related to preferences and self-limited, (by factors like conscience, free will etc.) makes this research much more difficult (Mercik 2011). It seems that what we are dealing with

are two types of intellectual capital: tacit and explicit. Intellectual capital is grey knowledge and is continually circulating and transforming within the network. It can be encountered in the internalized and externalized feedback loops that are formed between different network users and it accompanies the external (chatting, e-mails sending, etc.) and internal (listening, watching a commercial, reading comments, evaluation, observation, etc.) processes.

The conceptual part should end with development of a holistic model of intellectual capital flow including all of the mentioned objects (people, companies, regions, countries, organizations, etc.) expressed as multidimensional matrix of intellectual capital flows. Using the model of the intellectual capital flow may also allow to determine and describe the unit of intellectual capital. The need for such a unit is evident, and the possibility to operate with units of intellectual capital could change the way the capital is perceived.

The proposed approach to intellectual capital flows differs from the standard concepts of intellectual capital, which propose analysis of characteristics of people and individual elements of structural capital at company level; while indicators of social welfare are analysed at country level. A breakdown of intellectual capital for organizations at various levels is not feasible at current state of knowledge, and a proposition of measurement of intellectual capital will thus be a turning point in the scientific approach to this issue. Representation of intellectual capital of various level organizations in the form of homogeneous values will also help to conduct research in the field of intellectual capital flows and their forecasting. Such study has not yet been carried out, and will determine mechanisms affecting the migration of capital and its dynamics. A tool to help to manage these flows, including supporting software, may be created a by-product of the study.

5. Application layer

The main task of the application layer is to verify the created models and concepts of intellectual capital for each object on the basis of data in different databases (initial databases for analysis are presented in Table 4). It is assumed that the primary focus will be a verifying analysis of intellectual capital for regions at various levels. For objects contained within regions, results of verification will allow to confirm the model's correctness. For parent organizational

units (e.g. countries), or cross-regional entities (e.g. multinational companies) the tools in question will provide the basis for their individual analysis. The applied verifying analysis model will therefore provide a multi-dimensional map of intellectual capital resources for selected regions (units) and will help to determine intangible factors in the development of the area. For example, it can facilitate developing of a map of the Polish national and regional distribution of intellectual capital at NUTS 2 and NUTS 3 levels. As a result, the map of intellectual capital across regions / countries may form the basis for determining scenarios / profiles for the development of these regions, including the assessment of the impact of intellectual capital on the increase of the competitiveness of regions considering their role, involvement, etc. It seems that the character of application results should be universal enough to make it possible to develop recommendations for other EU regions.

Table 4. Databases of various elements of intellectual capital

Level of analysis			
Country	Region	Company	Person
Central Statistical Office	Central Statistical Office	GoldenLine*	GoldenLine*
Bloomberg	Eurostat	LinkedIn*	
Bureau Van Dijk	Google Trends*	Bloomberg	Legal and Commercial Service
Thomson Reuters	European Spatial Planning Observation Network (ESPON)	Legal and Commercial Service	Neurobiz
EMIS	Cambridge Econometrics	Neurobiz	Facebook*
Money.pl	The Vienna Institute for International Economic Studies (WIIW)	Bureau Van Dijk	Pracuj.pl*
Bankier	Eurostat LFS (Labor Force Survey)	Dealogic	Praca Money.pl*
Eurostat		Thomson Reuters	LinkedIn*
Google Trends*		Facebook*	Google Trends*
Organization for Economic Co-operation and Development (OECD)		EMIS	
Flash Eurobarometer		Notoria	
European Commission		Pracuj.pl*	
World Economic Forum		Praca Money.pl*	
National Science Foundation (NSF)		Money.pl	
Worldbank		Bankier	

Source: own elaboration. *) Technically speaking, these are not databases but portals.

In the application layer, a tool for the management of intellectual capital flows will be created. In terms of software, it requires a creation of a platform that integrates data sets from different databases. Most of the database systems have application programming interfaces (API), through which the platform can receive data and, in predetermined intervals of time, perform an analysis of intellectual capital flow between designated objects. The designated ranges for the exchange of information between the platform and the database systems would directly represent models of the dynamic flow of intellectual capital as developed in conceptual part. Ultimately, the platform can generate a report on detected changes in levels of intellectual capital for the designated objects and areas, and operate under the minimal human supervision (Tomingas et al. 2015). As part of the intellectual capital management, the platform would constitute a complementary tool facilitating decisions by generating tips based on the so-called expert system.

As a part of the computer system that emulates the human-expert decision-making process (the expert system), a data warehousing system should be designed to serve as a knowledge base. Applications should be developed to implement the algorithms developed in the conceptual part and providing sets of reasoning rules (Kumar, Singh, 2015). As the final stage is considered, we plan to develop EIS (Executive Information Systems) which will integrate ES with database (Fong 2015). The user interface requires developing a mechanism for explaining and interpreting the results in a manner understandable to people (Carvalho 2015).

Model flow of intellectual capital will therefore be multi-layered graph one or multivalent, partially addressed with logical conditions imposed on both the input and output apex, where the vertices are objects between which there is a transfer of intellectual capital, and the arcs represent the relationships between those objects. It should be assumed that the relationships will not only be of correlational type.

Both parts of the model, (i.e. both the conceptual and application parts and, above all, intellectual capital flows) lead to the goal of understanding of the place, role and importance of intellectual capital in the development of society and above all, to answering the question why and what causes the observed changes in the level of intellectual capital.

6. Summary

The presented research program offers interdisciplinary, comprehensive approach to the flow of intellectual capital. Intellectual capital seems to be the primary factor influencing prosperity for not only a single person, but also for every element of society in which man participates. All the more surprising, the research to date only offers analysis of its level and changes, but not its flow. Perhaps the main reason behind it is complexity and multidimensionality of the phenomenon.

We assume that it is not so much intellectual capital as its flow which is critical in the analysis, and suggest a testing regime whose implementation, although complex, is still possible. Clearly, continued implementation will raise further questions, including methods of influence on specific flows.

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