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Strategies of the universities in managing the intellectual capital within the smart city concept: Narrative literature review

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ABSTRACT

Smart City is the basic concept of urban development; it is based on technological solutions and intellectual capital. The universities are the principal structures developing the intellectual capital in the modern society. They often have the necessary technologies, but there is a significant gap between the existing solutions at the universities and their implementation in smart city. The origin of this problem is in the improper procedure of transferring these solutions from university to the city, business, state. The goal of this research is to present the existing possibilities of the universities in creating, developing, transferring and implementing the intellectual capital for the development of smart city. There presented the models of intellectual capital, intellectual capital is considered as an intellectual asset and its management is considered in accordance with the different types of the university. This procedure becomes possible due to the proper narrative literature review. Therefore, the described methodology of the literature review, integrating the various options of writing the systematic and the narrative reviews, is of special value.

KEYWORDS:

smart city concept, methodology of literature review, intellectual capital, intellectual property, intellectual assets, university, narrative review.

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1. INTRODUCTION

Based on the provisions of sustainable development and the fourth industrial revolution with the implementation of Industry 4.0, one of the most promising paradigms of urban development is the concept of a smart city. Despite the advantages of this concept, it is criticized for the insufficient assessment of the possibilities of self-regulation mechanisms, the roles of social groups, utopianism and other circumstances [Hollands, 2015; Kandt, Batty, 2020]. Nevertheless, smart city seems to be the most acceptable concept of urban development, and therefore, its concept requires improvements and further development.

The design of contemporary information and communication technologies creates the environment for interrelations and cooperation of universities, business, state and other structures in the process of solving the issues of city development. The source and the constituent part of these technological solutions is intellectual capital, which is the most valuable resource for the modern economy and simultaneously one of the most difficult resources for management and implementation.

Universities are the principal source of intellectual capital; nevertheless, there are certain problems concerning the efficient cooperation between the stakeholders in the process of transferring the technologies for implementing in the smart city. This fact requires the universities to discover and to solve the urgent tasks connected with the intellectual capital transfer and implementation.

The inconsistency is based on the fact that the universities usually apply the maximum efforts to determine the necessity and to find the proper technological solution for business and for the state; but further there appeared the problem since the lack of possibilities to transfer these solutions to the city. Therefore, one of the most urgent tasks is not only to design and develop the technology, but also to create the procedure of transferring and implementation of this technology.

The goal of this article is to familiarise the institutions and structures, which are interested in implementation of intellectual capital in smart city, with the possibilities of creation, development, transfer and application of contemporary technologies for the development of smart city.

It is possible to consider all the issue and to achieve the set goal only in case of proper well-structured review of scientific publications. Therefore, the research involved the elaboration of methodology for various options of literature review and choice of the most appropriate one for this study (the narrative review).

2. RESEARCH METHODOLOGY

The implementation of the set goal implies the presentation of information in the form of literature review, since the review articles help both experts and non-specialists to find the way around a great flow of publications. This document presents the result of the synthesis of literature that reveals the issues of intellectual capital management for the development of a smart city using the university database.

2.1. METHOD OF WRITING THE REVIEW

There are many recommendations in the scientific publications devoted to the methodology of writing the review articles; the type of recommendations are determined by the specific kind of review. Therefore, in order to write a high-quality review in accordance with the requirements of the scientific community, it is first necessary to determine which type of review articles gives the best matches with the aim of the article.

There are several classifications of literature reviews in the scientific publications; moreover, there exists a certain confusion regarding the genres of literary reviews, and there emphasized the lack of agreement on the methodological approach to reviewing the previous literature [Templier, Pare, 2018]. For the most part, there distinguished two

large groups among the review articles: systematic and non-systematic or narrative review [Ferrari, 2015; Byrne, 2016; Templier, Pare, 2018], which are in turn divided into subgroups. For example, J. Paul and A.R. Criado divide the systematic reviews into theory-based, method-based and meta-analytical, and domain-based reviews [Paul, Criado, 2020]; the latter, in turn, are divided into structured review, framework-based review, bibliometric review, hybrid-narrative review, and review aiming for theory development. At the same time, M. Templier and G. Pare, based on the analysis of the literature, developed a cumulative classification of nine types of literature reviews: narrative, descriptive, scoping, critical, meta-analysis, qualitative systematic, umbrella, theory development and realist [Templier, Pare, 2018].

Based on the classification by Paul and Criado [Paul, Criado, 2020], it is possible to assume that the domain-based type of reviews is suitable for the goal of this article, while the scientific community supposes that the purpose of all Systematic reviews is to present a modern perception of the research topic, to identify the gaps and the path of future researches, which does not quite coincide with the goal of this review. Moreover, according to the recommendations of PRISMA (preferred reporting items for systematic reviews and metaanalyses), a *systematic review* is a review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically evaluate the relevant studies, and also to collect and analyse the data from the researched studies [Moher et al., 2009]. The systematic review necessarily comprises the process of "selection, based on the criteria", while the narrative reviews may not describe the methods used for articles selection [Ferrari, 2015].

The researchers [Webster, Watson, 2002; Collins, Fauser, 2005; Greenhalgh et al., 2018], PRISMA [Moher et al., 2009] and organization Cochrane [Pollock et al., 2018] point out such strengths of the systematic review, as a narrow focus of the question, a comprehensive search for arguments, the selection of relevant evidences based on the certain criteria, a strict confidence assessment, an objective or quantitative summary, and conclusions based on facts. Systematic reviews have a great methodological accuracy, they are less biased (i.e. less dependent on the opinions of the author of the review), and are reproducible by other researchers when using the similar tools/literature search criteria.

However, according to J.A. Collins and B.C.J.M. Fauser [Collins, Fauser, 2005], the strengths of systematic review can turn into weaknesses, for example, when there needed a broader comprehensive coverage of information than the regulatory methods of systematic review can provide. According to these authors, the traditional narrative review should be used for a broad coverage, and a more optimal option presupposes supplementing them with the rigour of systematic reviews in terms of searching and relevance of the selected literature and writing a conclusion, refraining from expressing the researcher's personal opinion. This view is consistent with the combined approach of the narrative literature review by R. Perkins and co-authors [Perkins et al., 2020]. Among the narrative literature reviews aimed at describing a phenomenon that have little contribution to the theory, there are narrative and descriptive reviews [Templier, Pare, 2018]. At the same time, narrative reviews mainly summarize the existing literature and provide extensive knowledge in a particular field [Green et al., 2006; Byrne, 2016]. Such reviews are considered as valuable for researchers, educators, and practitioners [Templier, Pare, 2018].

At the same time, descriptive reviews identify any interpreted patterns or trends over a certain period of time, collect and analyse the numerical data, and use the structured search methods to form a representative sample of published works in a particular field of research.

Based on the above described, *the narrative review* was chosen as the most appropriate form of review for the implementation of the goal set for this study, since it is this form that provides a broad overview of the current state of knowledge on the topic being presented. The information without a comparative critical analysis is offered in this article; this analysis was left outside the scope of the suggested review, so that the performed material is convenient for perception not only for researchers, but also for practitioners. On this purpose the authors also refused to present a bibliographic analysis of the literature that was investigated in the course of the study, offering the reader the selected articles only.

2.2. STAGES OF THE RESEARCH

While planning the research for writing the article, the authors developed the research stages, focusing on the purpose of the review and compiling the recommendations for systematic and descriptive reviews (tab. 1).

As a result, using a synthetic approach, the authors elaborated eight stages of the study (tab. 1), the transition through which was not linear, since when receiving new information at any stage, the essence and content of one or more other stages could be clarified. For example, the dictionary of search keywords and the list of articles that were finally included in the review were the most corrected ones.

Step-by-step implementation of the study

Stage 1. Creating a theoretical framework for the review:

Issues under consideration. In the course of the research, when new information was received, the issues and topics included and excluded from the review were clarified. In the end, the following questions were selected for the analysis in order to perform a broad cover of the problem of choosing a university strategy for managing the intellectual capital within the framework of the smart city concept:

1. University position within smart city concept.
2. Intellectual capital, intellectual property and intellectual assets.
3. Assets of the university.
4. Technologies transfer: managing the intellectual property as an intellectual asset.
5. Technologies transfer: managing the intellectual property as an intellectual asset.

6. Intellectual capital management models (intellectual capital maturity model, model of open data in university – industry partnerships).

Target audience. the authors considered the practitioners who are engaged in the management of universities and structures interested in using the intellectual capital for the development of a smart city as the main audience for which this review will be useful.

The article was written in order to help the target audience to comprehend the modern trends in this area and to show the possibilities of using the intellectual capital without prejudice to all stakeholders.

Stage 2. Selecting the databases for searching for the articles

The search for literature should not be limited to one channel of knowledge, it should cover all aspects related to the research topic [Shaffril et al., 2020]. Therefore, Google Scholar and direct search in Google were used for the selection, since Google Scholar is more open and inclusive compared to other platforms and the combination of it with direct search increases the chances of finding the maximum number of primary studies, reviews and other documents [Yasin et al., 2020].

Stage 3. Selection of the criteria for inclusion and exclusion of literary sources

Definition of keywords. In the beginning of the study, the keywords described in the abstract were used as keywords. Subsequently, after the initial analysis of the literature and clarification of the trends in the field under consideration, the list of keywords for search has significantly expanded. So the authors searched separately for articles on the types of assets and capital of university, methods of knowledge and technology transfer, types of universities, existing models of management and development of intellectual capital of the university.

Determining the time span of the review. According to [Webster, Watson, 2002], writing an integrative literature review involves using the past and the present researches to explore the future. Therefore, from the very beginning the search depth by time was limited by the availability of

Table 1
Stages of the research

Stage	Stage content	Source
1	Creating a theoretical framework for the review: identifying the issues and topics under consideration in accordance with the purpose of the study, oriented on a broad coverage of the topic under consideration. Selection of target audience.	[Ensslin et al., 2013; Jennex, 2015; Arafah, Winarso, 2017; Templier, Pare, 2018; Paul, Criado, 2020; Tocto-Cano et al., 2020], PRISMA, Cochrane, Proknow-C
2	Selecting the databases for searching for the articles	[Jennex, 2015; Ruhlandt, 2018; Perkins et al., 2020], PRISMA
3	Selection and definition of the criteria: – Keywords; – The time span of the review, and also; – The criteria for inclusion and exclusion of articles in accordance with the requirement for their representativeness and correspondence to the purpose of the review.	[Keele, 2007; Jennex, 2015; Ruhlandt, 2018; Paul, Criado, 2020; Secundo et al., 2020; Tocto-Cano et al., 2020], PRISMA, Cochrane
4	The preliminary and pilot selection using the various combinations of search terms, including the ones for evaluating the volume of potentially relevant researches.	[Keele, 2007]
5	Selection of articles according to the chosen criteria, as well as by their title, abstract, conclusion and skimming.	[Ensslin et al., 2013; Mariano et al., 2017; Ruhlandt, 2018; Templier, Pare, 2018; Secundo et al., 2020], Proknow-C
6	Preliminary synthesis of the selected recordings based on the full text.	[Mariano et al., 2017; Ruhlandt, 2018; Templier, Pare, 2018; Perkins et al., 2020]
7	The final selection of articles sufficient for a broad, but not thorough, coverage of the topic under consideration according to the purpose of the review.	[Mariano et al., 2017]
8	Narrative synthesis: complete synthesis and compilation of the entire descriptive overview	[Jennex, 2015; Mariano et al., 2017; Templier, Pare, 2018; Perkins et al., 2020; Tocto-Cano et al., 2020]

electronic versions of publications. At stage 7, if there was no damage to the authorship, only the mostly late publications starting from 2009 were left, in other cases they referred to the original sources starting from 1992.

The criteria for inclusion and exclusion of articles in accordance with the requirement for their representativeness. The presented review cannot be considered a systematic review of the literature. However, the selection of sources and the presentation of information were guided by recommendations to the selection (inclusion) criteria implemented in the systematic reviews (tab. 1):

1. For scientific journals the authors used their rating: availability of bibliographic information and citations in databases, JCR or SJR.
2. For scientific articles: analysis of authors and citations – number of citations, citations per year and collaboration between authors.
3. For grey literature: the status of the author and / or the organization that published the report or other document, for example, WIPO, PRISMA, European Commission, etc., as well as the intended value for the target audience and / or the integrity of the report.

The exclusion criterion could be one or more of the following factors: duplicate information, lack of citation or parallel consideration of similar information, low rating of the journal or organization, low rating of the author, lack of perceived value forthe target audience and / or integrity of the report.

Stage 4. Preliminary and pilot search

At this stage, the articles were selected by keywords, title, annotation, conclusion, and using diagonal reading (skimming).

According to the recommendation of [Webster, Watson, 2002], the search was started with the main articles, namely with the leading journals and conferences in the field. At the same time, in this case, restrictions on the status of the publication were not applied and various types of publications were considered: reviews, journal articles, conference proceedings, abstracts and grey literature, etc.

At the same time, the special attention was paid to the grey literature, which is usually collected at the initial stage. This literature includes official documents, publications and reports of organizations, abstracts, conference proceedings, technical specifications and standards, company white papers, discussion boards, and blogs. Such literature, on the one hand, usually does not pass peer review, but, on the other hand, it can be of high quality, detailed research and can contain up-to-date information, so it is considered useful in scientific society [Yasin et al., 2020]. In addition, when analysing the intellectual property, first of all, it was necessary to rely on regulatory documents from WIPO, ISO, European Commission, etc.

At this stage, the authors clarified the research questions and the list of keywords for further search and selection of articles.

Using the possibilities and optional rigour that *the narrative reviews* allow, when choosing the performed models of the intellectual capital management, the authors were guided by the following points: first, the expected value of information for a wide audience interested in the topic of the review; second, the number of citations and the quality of reviews on the models; third, the greatest proximity of the models to the topic of the review and the opportunity to present a complete integrated view of the possibility of intellectual capital management from the perspective of the topic under consideration.

Stage 5. Selection of articles according to the selected criteria

At this stage, a preliminary *redundant* list of articles (including duplicated information) related to the research area was compiled. The relevance of the articles was assessed by the number of citations [Secundo et al., 2020] and the expected value for the target audience and/or the integrity of the report. At this stage, the information presented in the articles was checked against other sources, and from 10 to 45 publications were considered in parallel on one issue.

In the end, the authors followed [Webster, Watson, 2002]: "You can gauge that your review is nearing completion when you are not finding new concepts in your article set."

Stage 6. Preliminary synthesis

At this stage, the entries were selected based on the full text and its value for the completeness of the final version of the review. Simultaneously information on research issues was systematized. At this time, the articles with repetitive information were filtered out: there was left either the original source or a review article, where a broad overview of the issue under consideration was presented with initial information from different authors.

As a result, a final list of questions was drawn up, and it was decided to include these questions in the study report.

Stage 7. Final selection of the articles

Based on the results of Stage 6, the final selection of the articles sufficient for a broad, but not thorough coverage of the selected issues was carried out. So, for example, the authors give up on considering in detail such voluminous issues as technology transfer and asset management methods, providing readers with links to the articles with more detailed information. At the same time, the most valuable articles were selected according to the selection criteria, and the remaining articles were excluded from the report.

It should be noted that the performed review presents only the information that was relevant and confirmed in other sources, however, for the reasons mentioned above, the sources used for this purpose are not listed in the final list of references.

Stage 8. Narrative synthesis

At this stage, the final synthesis and correction of the grouped information was carried out, and the final integral version of the *narrative review* was compiled according to the set goal.

3. UNIVERSITY POSITION WITHIN SMART CITY CONCEPT

The concept of smart city is very complicated since it is first of all at the stage of development, and the researchers and practitioners are constantly adding the new properties to it, and then it integrates too many components to determine it unambiguously and unequivocally. This research operates under the following definition: A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business [Lai et al., 2020].

According to the European Commission, the goal of smart city is to allocate the resources efficiently with employment of information and communication technologies (ICT), keeping in mind not only economic effects but also environmental ones[1]. This resource allocation involves "smart" activities in all urban spheres, comprising transport networks, utilities, waste management, energy use and energy sources, etc. The final goal of all activities is creating safe, convenient and well administrated urban environment for all groups of population.

Schematically the spheres of development of smart city can be divided into six big zones (fig. 1), which do not intersect in the diagram, but in real life conditions they cannot exist independently, and always tend to create the interrelations and links.

Fig. 1. Smart city zones of development

Foot-note. The university is a very special structure within smart city concept. It is impossible to allocate it in only one zone of smart city. And the complex role of the university is connected first of all with its function to create, keep, upgrade, transfer, share, implement knowledge. The university is the most important pillar of Know-ledge Management.

There are numerous researches emphasizing the role of university in administrating and managing the intellectual capital and intellectual assets within smart city [Dameri, 2017].

According to [Ardito et al., 2019], the role of university changes, depending on the zone and processes where it functions: interaction with governance can give the university the role of knowledge intermediary in internal processes and knowledge gatekeepers in external processes, they can operate as knowledge creator and knowledge evaluators, and so on.

However, the role of the university is not restricted by education, and the epoch of knowledge economy emphasizes the importance of the university as a centre for elaborating, processing, distributing and implementing intellectual capital and knowledge in smart city.

4. INTELLECTUAL CAPITAL, INTELLECTUAL PROPERTY AND INTELLECTUAL ASSETS

The intangible issues have become of a special interest in the epoch of globalisation and information, and each branch of science has its own approach towards these issues.

Intellectual capital is one of the most popular topics in the scientific researches. It is due to the fact that on the one hand as any capital it is capable of generating value, and on the other hand it is actually intangible and difficult to reveal, measure, determine, etc. It is difficult to define it due to its blurred nature and to the fact of including the different concepts of intellect and capital [Bratianu, 2018]. According to [Roos et al., 2017], intellectual capital is represented by non-monetary and non-physical resources, and company partly controls these resources to create the value of the company. Researchers usually take the intellectual capital as an important asset of the company despite the fact that it is not recorded in the financial statements and not estimated in book value terms [Mar et al., 2005]. Nevertheless, it is not only an important factor improving the company financial performance [Nadeem et al., 2019] but also capable of creating sustainable competitive advantage for business structure [Salvi et al., 2020]. It is especially important for such structures as universities, which not only involved nowadays in study of managing and reporting of intellectual property, but also in concentrate on investigating the practical employment of intellectual capital. They are at the cutting edge of technologies and innovations transferring procedure [Secundo et al., 2018].

Intellectual capital can be considered as *intellectual property* in case it is controlled by the company. Intellectual property traditionally refers to patents, trademarks, copyright, design rights, trade secrets – therefore, it is possible to conclude that the main function of intellectual property is to protect the ownership of intellectual capital. According to D. Koh and co-authors, besides protecting

[1] European innovation partnership on smart cities and communities, operational implementation plan: First public draft (2014). European Commission Retrieved, June. URL: http://www.ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf.

the business investments, intellectual property provides the possibility for implementing the creative potential, managing the intellectual activities and creates the "zone of personal autonomy" [Koh et al., 2020]. Though intellectual property is considered as protective means of the company, there is such intangible asset as Goodwill (brand, reputation, customer database, image, etc.) [Kalinina et al., 2019], which basically different from protection function though it is intellectual property. Moreover, it is the asset created due to the proper and intelligent employment of intellectual capital. Thus, it is wrong approach to consider the intellectual property as the protection means only. Goodwill can comprise numerous components depending on the field of company functioning. In concern with universities it is more important property than any other ones. In case the university has insignificant goodwill, which is its reputation, it cannot serve the means for transferring technologies and innovations successfully. The logic is quite simple – if the university is not able to create the intellectual property – reputation – it cannot provide the high-quality service for transferring, protecting and managing such properties for other structures.

Another important feature of intellectual property is active interest of numerous public, international, business, administrative and legal institutions to the issue. They describe and define the components of it, paying special attention to the industrial field[2, 3].

There are special tools for studying the intellectual property. One of them is IPA – intellectual property analytics. This tool is used for discovering the existing relationships and tendencies via analysing the big volumes of intellectual property information. This tool can be successfully employed by the universities in their work with intellectual property [Aristodemou, Tietze, 2018].

Intellectual capital and intellectual property have become an important *asset* of the company. The situation when the stock value of the company is significantly higher than its book value is not surprising in the time of globalisation. It is the main function of intellectual assets – to create additional value for the business using the intellectual property and intellectual capital. Therefore, it turns that the intellectual assets comprise two constituent parts – intellectual property and intellectual capital [Spasić et al., 2018]. Intellectual property has certain tangible implementation – it can be protected by the law, it can be controlled by means of company, it can be bought, sold, administrated[4]. The second component – knowledge asset (intellectual capital). It includes know-how, ideas, concepts, information, expertise, theories, rationales, results, observations, methods, instructions, solutions, etc., most of which are not subjected to legal protection [Spasić et al., 2018]. It is supposed, that some specific measures can protect such assets, for example, non-disclosure. However, if this measure can work for conventional business company, it is not viable for the university, since academic environment presupposes openness and exchange with information within the academic community; therefore, the attempt to protect them is natural for any business structure but is in conflict with university nature and ethics.

Therefore, the peculiarity of the university as a centre of knowledge within smart city is specified by its special role for all areas of smart city concept on the one hand, and its quite specific position as the holder of intellectual capital and assets on the other hand.

5. ASSETS OF THE UNIVERSITY

The capital of the university can be divided into the following categories: Material, Intellectual and Financial capital. Intellectual capital in its turn can be divided into human and structural capital, and structural capital can be divided into relational, organisational and customer; organisational capital is subdivided into innovation and process ones (fig. 2) [Brooking, 1998; Leitner, 2004; Karchegani et al., 2013].

- *Financial* and *material* types of capital are very important assets of the university; nevertheless, the study of these kinds of capital are beyond the frameworks of this research, and they are not considered there. Other types are described below.
- *Technological capital* is technological resources available at the university. It is considered as a combination of material and non-material components [Grigoriev et al., 2013]. These are technological resources available at the university, such as bibliographic and documentary resources, archives, technical developments, patents, licenses, software, databases, etc [Ramírez, Gordillo, 2014]. Technological capital is associated with an enterprise's investment in R&D, brand, and organisation capital. This capital can be used simultaneously in several domestic and foreign regions. At the same time, foreign technological capital is used to finance foreign direct investment by multinational corporations [McGrattan, Prescott, 2009]. The intangible elements of technological capital are related to the components of intellectual capital (fig. 2) and integrate three elements: equipment, employees' competencies, and technologi (fig. 4).
- *Human capital* is the sum of the explicit and implicit knowledge of all university employees acquired via formal and non-formal education and professional development processes. As defined by Meritum Guidelines *Human capital* is defined as the knowledge that employees take with them when they leave the firm. It includes the knowledge, skills, experiences and abilities of people. Some of this knowledge is unique to the individual, some may be generic. Examples are innovation capacity, creativity, know-how and previous experience, teamwork capacity, employee flexibility, tolerance for ambiguity, motivation, satisfaction, learning capacity, loyalty, formal training

[2] Intellectual, industrial and commercial property. Fact Sheets on the European Union (2020). European Union Parliament. URL: https://www.europarl.europa.eu/factsheets/en/sheet/36/intellectual-industrial-and-commercial-property.
[3] Understanding industrial property (2016). Geneva, Switzerland, World Intellectual Property Organization. URL: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_895_2016.pdf.
[4] Ibid.

and education [Cañibano et al., 2002].

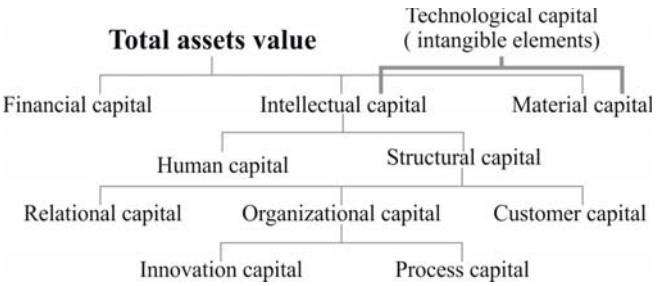
- *Structural capital* is defined as the knowledge that stays within the firm at the end of the working day. It comprises the organizational routines, procedures, systems, cultures, databases, etc. Examples are organizational flexibility, a documentation service, the existence of a knowledge centre, the general use of Information Technologies, organizational learning capacity, etc. Some of them may be legally protected and become Intellectual Property Rights, legally owned by the firm under separate title [Cañibano et al., 2002]. It can be divided into:
  - *relational capital* is defined as all resources linked to the external relationships of the firm, with customers, suppliers or R&D partners. It comprises that part of Human and Structural Capital involved with the company's relations with stakeholders (investors, creditors, customers, suppliers, etc.), plus the perceptions that they hold about the company. Examples of this category are image, customers loyalty, customer satisfaction, links with suppliers, commercial power, negotiating capacity with financial entities, environmental activities, etc. [Cañibano et al., 2002];
  - *customer capital (market capital)*. It is the main factor in achieving the market value of IC; it contributes to the conversion of IC into a market product. In its turn, the development of this capital depends on human, structural and innovative capital [Chen et al., 2004];
- *Organisational capital:* the operating environment comes from the interaction between research, management and organizations processes, etc.;
  - *innovation capital* is related to intellectual property, human capital and is defined as the ability to generate new knowledge, as well as a set of opportunities for updating the firm, for creating new products and services for commercialisation. This capital is directly related to R&D expenditure [Chang, Hsieh, 2011]. It is considered that subjective well-being, objective happiness, and creativity are important predictors of entrepreneurial initiative and innovative capital [Usai et al., 2020];
  - *process capital* described as the combined value of the company's processes [Lövingsson et al., 2000] with efficient production processes, a more efficient cost profile and customer satisfaction. It involves optimisation of the operational cycle and internal processes to improve the relationships with customers [Tjahjadi et al., 2019].

Fig. 2. Division of the capital of university
Sources: [Lövingsson et al., 2000; Grigoriev et al., 2014].

The components of IC can be linked and mutually dependent: J. Chen and co-authors showed that human capital can significantly affect both structural and client capital, as well as structural capital affects both innovation and client capital (fig. 3) [Chen et al., 2004].

Fig. 3. Interrelation between the components of IC

Fig. 4. Graphical representation of the technological capital concept

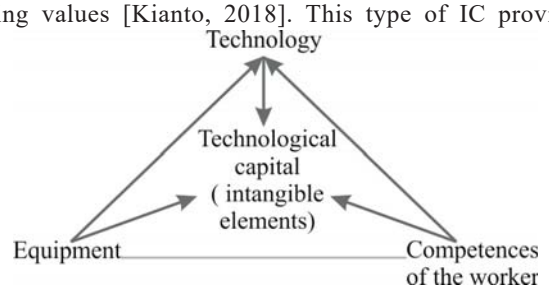


Sources: [Lövingsson et al., 2000; Grigoriev et al., 2014].

As all organisations, the university uses its assets for creating the value. If intellectual capital differs by types, it has different functions, and therefore the university has possibility to employ different types of intellectual capital for creating value and for developing various functions of smart city.

The potential of the university is represented by

intellectual material that includes knowledge, experience, information, and intellectual property and is involved in creating values [Kianto, 2018]. This type of IC provides



opportunities in all smart city dimensions in case if they are used by the university for implementing certain smart solutions.

Knowledge, expressed in a clear, unambiguous and easily transferable form can serve as a resource of the university [Nonaka, Nishihara, 2018]. It is important: not each resource is used by the organisation, and intellectual capital is not exclusion. If the university does not implement the existing knowledge for implementing in smart solution, the potential of the university in smart city would not become viable.

The value of the aggregate of intellectual assets available to the university, including intellectual property, natural and acquired intellectual abilities and skills is the result of implementing the intellectual capital [Pedro et al., 2020]. It is the implementation of intellectual activities of the university in smart city, smart solutions which appear as a result of university participation in the processes of smart city.

Table 2
Summary: Roles, determinants and engagement modes of universities

Model	Knowledge "factory"	Relational university	Entrepreneurial university	Systemic university	Engaged university
Main role of universities	Production of scientific knowledge	Exchange of knowledge	Active commercialization role	Boundary-spanning role	Developmental role
Main unit of analysis	Innovation outputs	Linkages	Intermediaries (e.g. TTOs)	Systems/networks	Spaces of governance
Main partners/ beneficiaries	High-tech firms located in proximity to universities	Large manufacturing firms	Large manufacturing firms Spin-off firms	Regional clusters Regional SMEs	Regional stakeholders
Directionality of engagement	Unidirectional (implicit)	Bi-directional (implicit)	Bi-directional (explicit)	Triple-helix (universities, industry and government)	Responsive
Dominant methodolo-gy	Industrial surveys Citation count Production function analysis	Industrial surveys Case studies	Surveys of university TT managers	National and regional innovation surveys Case studies	Case studies
Key factors influencing impact	Research intensity/ inputs Geographical proximity	Structural factors (size of firm, age, sector, R&D intensity) Innovation strategy	Organizational structures/ forms Managerial practices Faculty behaviour/incentives	Regional system configuration Regional policy Institutional capacity of universities	Number and synergies between universities University leadership Joined up policies/incentives
Policy implications	Co-location of firms and universities Increased funding for research	Some links should be promoted vis-à-vis others	Intermediaries and organizational arrangements/incentives are needed to ensure links	Institutional arrangements are important to ensure linkages	Joining up of universities missions and other policies at different levels

Source: [Uyarra, 2010].

Therefore, intellectual capital is a full-fledged capital, and it means, it can and must be managed by the university.

Obviously, the management of different types of IC, if to consider IC as an asset, should differ. The main models for managing this asset consider technological capital as a materialised form of intellectual capital, and there appeared more and more models considering the relational capital, allowing the remaining parts of the IC to be implemented in the real economy and to be commercialised.

According to [Sveiby, 2000], there are 42 methods for evaluating IC, which can be divided into 4 groups:

- direct intellectual capital methods (DIC);
- market capitalization (MCM);
- return on assets methods (ROA);
- scorecard methods (SC).

One of the functions of IC is to transfer not only knowledge, but also technologies, which refers to transfer of innovative solutions protected by intellectual property rights. If knowledge and technologies are considered as components of IA, they need to be managed. Understanding this leads to the fact that universities are beginning to develop their own policies and tools for managing this asset. For knowledge transfer, including technologies transfer, there most often used formal and informal methods, which can be attributed to asset management methods[5]:

- obtain licenses;
- transfer of rights;
- cooperation;
- an agreement on data transfer;
- bargaining on the allocation of funds for research;
- consultations;
- franchising;
- formation of related companies and startups;
- training and courses;
- mobility of research staff and students;
- publications;
- conferences and meetings;
- informal exchange etc.

Universities today use various policies in the field of their intellectual property; intellectual property serves as the cornerstone of innovative and creative activities in higher education institutions and state research institutes. It provides an organisational and legal structure and a predictable environment for innovation.

6. TECHNOLOGIES TRANSFER: MANAGING THE INTELLECTUAL PROPERTY AS AN INTELLECTUAL ASSET

Academic work at universities and research institutes also leads to the creation of IP, for example, in the form of textbooks, dissertations, software or samples/prototypes.

[5] Knowledge transfer for universities. WIPO. URL: https://clck.ru/DhKmi.

Thus, it also becomes an object of asset management, and can also be considered from the point of view of various models of asset management.

Universities publish the results of their researchs, making them publicly available, which often conflicts with the industry's need to preserve the confidentiality of information and to protect it through IP rights, such as patents. Therefore, the existence of an institutional policy in the field of IA management is a prerequisite for successful cooperation between scientific institutions and their commercial partners.

The world leading universities have various internal systems for managing their own IA with similar goals, such as:

- advisory committees and innovation centers;
- TLO (technology licensing office) [De Souza, Urbina, 2019];
- CTM: the centre for technology management [Vinayavekhin, Phaal, 2020];
- research and innovation office [Dőry et al., 2018];
- spin-out in university technology transfer [Jonsson, 2020];
- as well as various organizations oriented on technologies licensing, university intellectual property offices [Bengtsson, 2017], etc.

Undoubtedly, universities are not necessarily limited with these structures and can use other centres for managing IA; the universities manage their own IA in accordance with the type of university, and building interaction with other institutions in different ways to develop innovations. Based on this, the following models of universities are considered by their roles and types of interaction with the system (tab. 2) [Uyarra, 2010].

1. Knowledge "factory" (producers of scientific knowledge).
2. Relational university (bidirectional communication and knowledge sharing processes between firms and universities).
3. Entrepreneurial university (the "entrepreneurial" aspect of universities is encouraged through special organisational activities at universities, such as the technology transfer department and technology parks, as well as legal changes and incentive structures).
4. Systemic university (borderline institutional "nodes" whose impact will be determined by the specific regional innovation system in which they are embedded).
5. Engaged university (the "developing" role is mainly attributed to this university, i.e. they are assumed as organisations that actively participate in the economic development of the regions in which they are located).

Accordingly, the management of intellectual assets in each type of university will focus on a specific type of IA.

For example, a "knowledge factory" type university: the main role of the university is assigned to training and localised impact of research in the form of scientific and economic results of companies located geographically close to the university [Jaffe et al., 1992].

The relational university model is characterised by closer bilateral cooperation between universities and the private sector (for example, the Bayh – Dole law [Mowery et al., 2008]), which generates an increase in the amount of useful knowledge, training of qualified graduates, new scientific tools and methodologies, social interaction networks, solving scientific and technical problems, and creating new companies [Salter, Martin, 2001]. At the same time, some studies show the increased role of informal relationships, as they are more trustworthy for universities and private businesses [Meyer-Krahmer, Schmoch, 1998].

Many universities that have been established in recent years are expected to have a significant positive impact on the regional economy in addition to other, more traditional missions [Nilsson, 2006].

7. INTELLECTUAL CAPITAL MANAGEMENT MODELS

Universities are considered to be the key players in innovation processes and in the development and implementation of smart specialization strategies (S3) or research and innovation strategies for smart specialization (RIS3) [Lopes et al., 2019]. According to L. Kempton and co-authors, university resources can have a high positive impact on the regional economy especially in case of less favourable regions with a weak private sector [Kempton et al., 2014].

This fact explains the creation and implementation of various models of IP and IC management at universities, especially in Europe, describing the processes of IC formation, the relationship between universities and structures interested in their products, as well as the shift of IC towards practical application. This research focuses on two models only, one of these models describes the process of managing IC at the university, and the second one describes the possible communications in the process of creating and transferring IC.

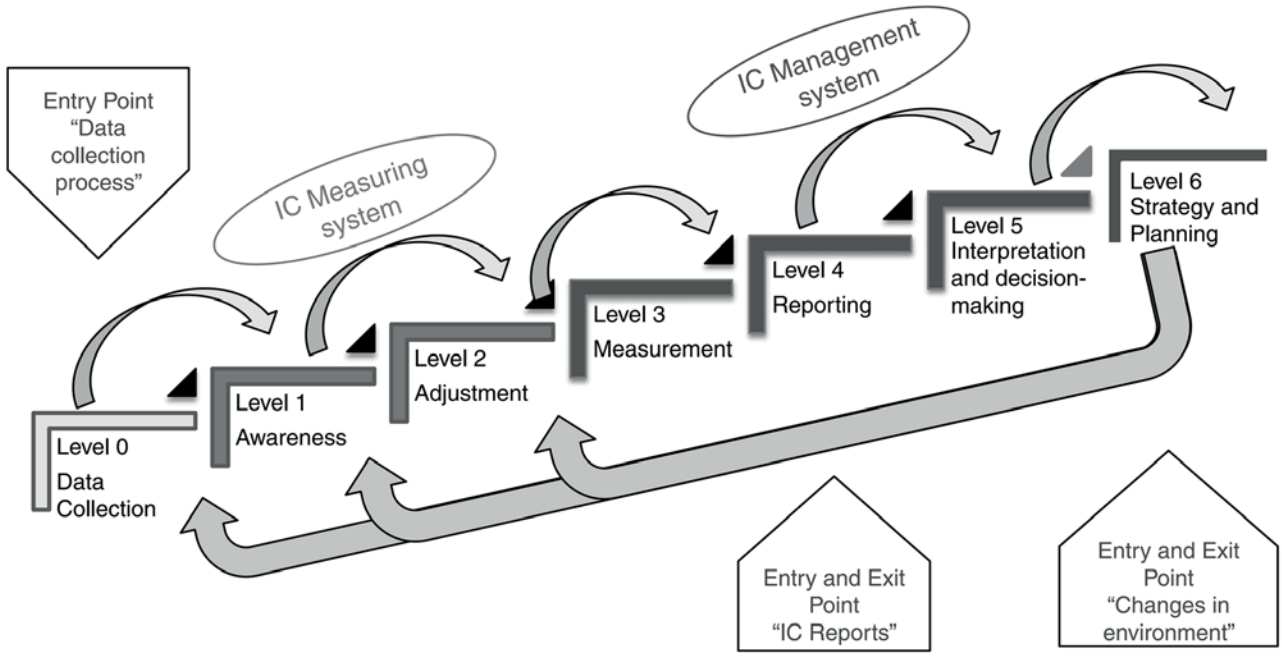
7.1. ICMM: INTELLECTUAL CAPITAL MATURITY MODEL

According to ISO, the maturity model is a model derived from one or more specified assessment model(s), that identifies the set of phased development or progress levels showing the assessment categories for community infrastructure(s)[6]. The maturity models are used to implement Industry 4.0 in such areas as education, health care system, energy, finance, manufacturing sector, government, and general use [Tocto-Cano et al., 2020].

According to G. Secundo and co-authors, there is no existing model, which is suitable for all educational institutions [Secundo et al., 2010]. Therefore, the author and his team developed the so-called intellectual capital maturity model (ICMM) with a flexible structure that can adapt to the individual properties of various institutions and different stages of management development [Secundo et al., 2015]. In general, the maturity models describing the elements,

[6] ISO 37153:2017. Smart community infrastructures. Maturity model for assessment and improvement.

Fig. 5. Diagram of the intellectual capital maturity model



Source: [Secundo et al., 2014].

levels, and order of effective processes[7] according to the ISO standard, are useful because they allow organisations and institutions to make a self-assessment of the maturity of various aspects of their processes in relation to the criteria. The main objective of this model is to manage efficiently the intangible assets and IC, which make up the largest share of university assets [Sánchez et al., 2009].

Each level corresponds to a certain maturity of intellectual capital management (fig. 5):

– the full cycle of the intellectual capital maturity model includes [Secundo et al., 2018];
– seven levels;
– three entry points (data collection process, intellectual capital and Strategy and planning reports), meaning that an institution can start moving from any level with the model, depending on the degree of management maturity (for example, universities working with intellectual property can start from level 4);
– two exit points (reports on intellectual capital and environmental changes), which mean that the institution may stop the process and not complete the full development cycle for various reasons.

The authors limit the use of this model by four risks and limitations:

1. The universities should be independent in developing strategies and independent of political bodies.
2. Implementation of the model requires strong leadership and the right to own the results. The largest investments are made in the initial stages, but the benefits are received only in stages 5–6, and without influential leadership the university may get stuck in the initial stages or even abandon the entire process altogether.
3. There is a risk of implementing several levels of intellectual capital management at once: if there is no synthesis of the "new" when moving between maturity levels, the benefits of intellectual capital management may be offset by a sharp increase in costs.
4. Moving forward too quickly will also be risky. It is possible to go from level 0 to level 6 in a single budget year, which can undermine the hidden value of discussions and consensus-building. In the end, effective strategies are not those that are written in the shortest possible time, but those that successfully mobilize collective efforts and produce results.

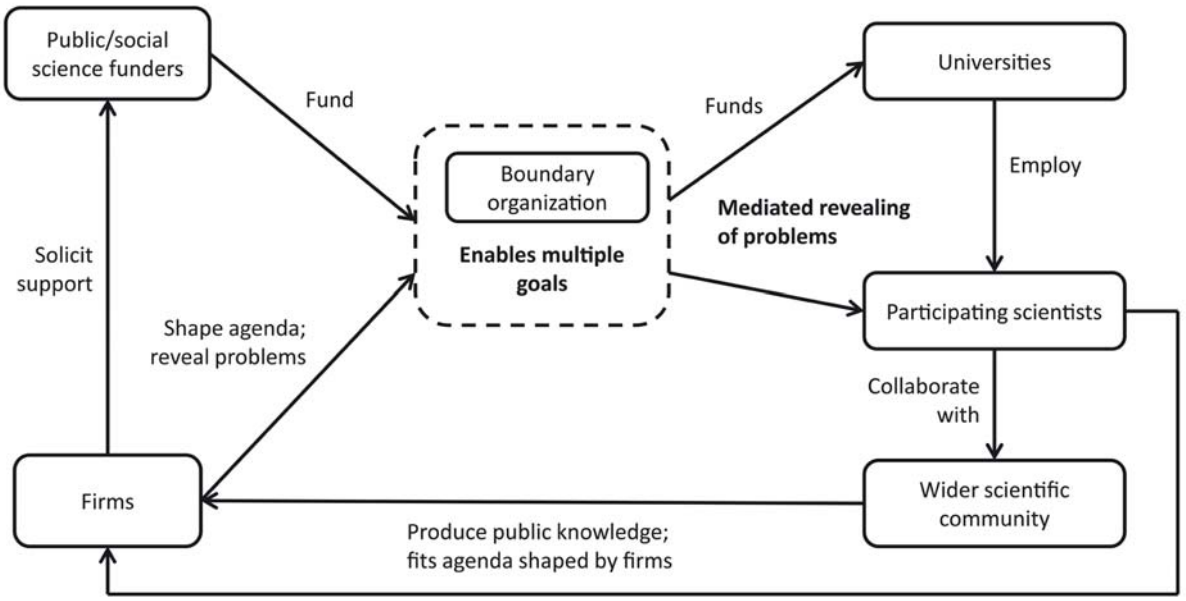
According to the opinion of the authors of the model, its application, on the one hand, will facilitate the access to information held by the university for the stakeholders, and on the other hand it will help universities to provide information useful to stakeholders, which will help all parties to make better decisions, improve the articulation of public policy and increase transparency of the entire system of obtaining new knowledge and turning it into assets, or intellectual capital. The presented intellectual capital maturity model serves as a theoretical basis for the movement of intellectual capital from theory to practice.

7.2. MODEL OF OPEN DATA IN UNIVERSITY – INDUSTRY PARTNERSHIPS

The next noteworthy model in the context of this research

[7] Systems and software engineering vocabulary (2010). Geneve, International Organization of Standartization, Institute of Electrical and Electronics Engineers.

Fig. 6. Open data model in partnerships between universities and industry



Footnote. In bold – key mechanisms.
Source: [Perkmann, Schildt, 2015].

and trends in intellectual property and intellectual capital management is the open data model for university-industry partnerships presented by M. Perkmann and H. Schildt [Perkmann, Schildt, 2015].

The model is built in the modern paradigm of "Open innovation" [Marcet, 2008], which promotes more flexible policies in relation to R&D and intellectual property and finds a response in various fields of knowledge [Murray-Rust, 2008; King, Persily, 2020; Marinho et al., 2020] including ones involved in the development of smart cities [Neves et al., 2020].

In this model, the key element is a structure called boundary organisations, whose main goal is to create and maintain the meaningful and mutually beneficial relationships between knowledge producers and users (fig. 6).

Boundary organisations provide opportunities and sometimes incentives for the creation and use of border objects (in particular knowledge and technology), and also include the participation of actors on both sides of the border, including professionals who act as intermediaries, using a balance of interests for all parties [Guston, 2001]. Such organisations provide an opportunity for knowledge/technology producers to have mutually beneficial cooperation with their users to get a more valuable and useful product [O'Mahony, Bechky, 2008]. Software helps competitors manage four critical areas of organisational practice: management, membership, ownership, and production control.

The authors of the model identify two key mechanisms that boundary organisations use to open the partnerships with data: "indirect disclosure" and the inclusion of multiple goals. The first mechanism allows companies to disclose their research objectives in a way that reduces the risk of unintentional disclosure of knowledge and simultaneously forms a collective research programme. The presence of several goals – industrial and scientific – shapes the activity in the way that the goals coincide with both the ambitions and professional practice of academic researchers, and the aspirations of consumers of scientific activity.

The model shows how the open partner data should be organized so that each party can benefit from the partnership, avoid potential conflicts, and pursue multiple goals, rather than optimize the activities and costs for purely industrial or purely academic purposes.

As intermediaries in data exchange, the boundary organisations included in this model can be an effective tool for promoting knowledge, which is based on knowledge-intensive industries, and can also help to benefit from open data exchange and minimize the risk that this information will be used unfavourably by competitors. The presented model not only shows the processes and ways of relations between "science" and "practice", but also, due to placing the boundary organisations in the centre of complex relationships, demonstrates the possibilities of using such an intermediary to prevent conflicts and resolve issues in complex relationships in the process of developing new technologies and turning them into intellectual capital.

8. CONCLUSION

Intellectual capital is a strategic asset for achieving the sustainable development goals and a driving force for technology policy development and sustainable growth [Secundo et al., 2020]. In this context, the creation, development, transfer and use of intellectual capital is a necessary condition for the development of a smart city. In case intellectual capital is supposed to be the necessary resource for the smart city development, the management

of intellectual capital is assumed to be one of the most significant problems for modern city.

There are several approaches and mechanisms for managing the IC at all stages of its formation under the contemporary conditions. People who are engaged in solving the practical problems sometimes do not have enough resources for a multi-level and broad study of theoretical issues, often they need reviews that will provide a modern view of the problem and the possibilities of its solutions. The goal of this article is to provide the stakeholders and organisations with an overview of the opportunities for creating, developing, transferring and employing the intellectual capital generated by the universities to develop the concept of a smart city.

This review comprises the issues of university assets, peculiarities of the formation of intellectual capital, intellectual property and intellectual assets on the basis of universities, procedures for managing the intellectual property as an intellectual asset; there also considered two models of intellectual capital management.

The frameworks of generalised data on the types of capital implemented in the universities contains the consideration of intellectual capital, consisting of human capital and structural capital, which in turn includes relational capital, customer capital and organisational capital, divided into innovation capital, process capital. At the same time, intellectual capital and material capital, according to some authors, make the technological capital of the university.

The leading world universities have different internal systems for managing their intellectual assets and for building interaction with other institutions for the development of innovations in different ways; there are five types of the universities: knowledge "factory", relational university, entrepreneurial university, systemic university and engaged university.

Considering the intellectual capital management models, this article focuses on the intellectual capital maturity model by [Secundo et al., 2015] and the open data model for university-industry partnerships presented by [Perkmann, Schildt, 2015]. Intellectual capital maturity model by Secundo and co-authors is chosen due to its flexible structure and due to the fact that it can be adapted to the individual characteristics of different institutions and different stages of management development. Open data model for university-industry partnerships presented by Perkmann and Schildt is chosen because, according to the modern concept, open data plays an important role in the creation and analysis of contextual and actionable data aimed at understanding, managing and planning the urban development strategies within smart city concept [Neves et al., 2020].

As a result, there presented the global vision of the intellectual capital as an asset, created by the university, and then developed, transferred and implemented, taking into account the use of various management models for the needs of smart city development.

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