

# Digital Component of Innovation Landscapes: Context of Sustainable Development at the Local Level

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**Abstract** – The article is devoted to the application of digital platforms and solutions in science and innovation policy field for the development of local innovation landscapes. The development context of local innovative landscapes is considered within the framework of sustainable development issues. The possibilities of using digital platforms and solutions for analytical purposes are determined. Methodological and practical aspects of creating a digital-based regional technology transfer network are proposed.

**Keywords** – sustainable development, digital platforms and solutions, innovation landscape, model, technology transfer

## I. INTRODUCTION

During the innovation process, knowledge is transformed into technology, products and services. At the regional and territorial levels, this process is carried out through an innovation landscape, which is a set of institutions and links established in the region that ensure the transfer of technology and knowledge between organizations, businesses and regions.

In the conditions of formation of knowledge economy the urgent task deals with the development of tools of management of innovation development; development of models of innovation infrastructure, evaluation and forecasting of innovation policy results, ensuring the coherence and coordination of actions of all actors. At the same time, one of the main problems is modeling the relationship of elements of the local innovation landscape and modeling their impact on sustainable development.

In this context, the innovation landscape is a promising and relevant subject of study, as it is now becoming increasingly important to ensure the competitiveness of the economy. To characterize the innovation landscape, a variety of indicators can be used, among which are the following: the number of organizations performing research and development; number of staff engaged in research and development; volume of innovation products etc. However, having a certain number of organizations or staff does not mean that their actions are aimed at sustainable development. That is why there is a need for a more thorough study of the interaction of the innovation

landscape. The article proposes a revised digital tools implementation framework, which acknowledges trends and supports local innovation landscape development in increasingly dynamic environments.

## II. REVIEW

Industry 4.0 revolution causes the transformation of social and economic systems [1]. This fact deals with the integrated approach context, given in [2]: “decision makers need to identify the optimal combination of solutions. Determining a suitable, tailored innovation mix for each country requires a systemic approach – combining innovations in technology with those in market design, business models and systems operation”. Among such innovation mix framework KPMG experts note localization [3] as a tool of adaptive management. The innovation landscape has significant potential for innovation mix practical implementation at the local level.

As part of innovation landscape development it is important to consider the change from off-line to on-line information, communication and services, affects relations and processes in ways that are fundamental for social life and society [4]. Digital innovation landscape links diverse entities such as processes, products, services, organizations, industries, and communities, as they draw on resources, including technology, attention, and knowledge, to create and realize the value of digital innovations [5]. Digital marketing tools in value chain of innovation product are important for innovation landscape development [6].

The review takes us on a journey across diverse digital landscapes drawing on different theoretical perspectives [7]. The by now established area of research on information and communication in digital society gives insights into technologies and the way they affect socio-demographic distribution effects [8]. According to [9] digital innovations introduces a new open-ended value landscape to anyone seeking to generate or capture new value. Digital resources serve as building-blocks in digital innovation, and they hold the potential to simultaneously be part of multiple value paths, offered through design recombination and assembled through use recombination.

These issues require the new innovation policies [10].

Within these issues we can mention the OECD Analytical Reports [11; 12], which notes that digital platforms and solutions in science and innovation policy field (DSIP) increasingly link different sources of information and use new technologies and applications that are increasingly used for innovation analytics. Innovation analytics is a well-established practice used by managers to identify strengths and weaknesses in innovation. Existing audit frameworks fall short, however, because they neglect such major trends that currently transform the innovation landscape [13]:

- shift from closed to more open innovation models;
- shift from providing physical products to industrial product-services;
- shift from analog to highly digitalized world.

The paper [12] discusses policy instruments to support digital innovation targeting such objectives:

- policies aimed at enhancing digital technology adoption and diffusion, including demonstration facilities for small and medium enterprises (SMEs);
- initiatives that promote collaborative innovation, including via the creation of digital innovation clusters and knowledge intermediaries;
- support for research and innovation in key digital technologies;
- policies to encourage digital entrepreneurship.

All given points and approaches can be realized within the regional innovation policies [14; 15] using different methodological approaches, including technological package [16], research and development (R&D) and education technologies (EdTech) resources [17] and resource security management [18].

### III. INNOVATION LANDSCAPE ANALYTICS

The problem of innovation landscape elements interaction and modeling of their impact on sustainable development is practically not considered from the point of view of strategic management and decisions providing tools. In this regard, there is a problem of creating models for decision-making on strategic development, i.e. models that allow to interpret and analyze existing information about the external and internal environment of the innovation landscape, to establish relationships between development factors, to monitor the region (territory) to strategic development guidelines.

That's why the first important aspect of DSIP application is analytical [19; 20]. Innovation analysis is a unified information system of qualitative and quantitative indicators, criteria and methods designed to assess the need, ability, feasibility and effectiveness of introduction and use of innovations in the activities of local entity without compromising its further functioning. From a theoretical point of view, the importance of innovation analysis can be illustrated through the development of the

theory of managed economy in terms of justifying the choice of vector of controlled variables. To achieve adequacy, it is necessary to increase the variety of problem statements with different innovation processes vectors.

The next aspect of the problem is related to the functional, information-logical and mathematical modeling of the structure and parameters of the innovation landscape depending on the innovation landscape (creation and implementation of innovations). The biggest problem is the formation of criteria for the possibility of a particular variant of the innovation landscape or even its optimality. The wrong selection of criteria can lead to the systematic degradation of sustainable development. It is important to create tools for modeling and managing local innovation development with simultaneous and multiple innovations. Based on the described theoretical and methodological provisions the development of a model for diagnosing the innovation landscape is based on the following requirements: the model is intersectoral; takes into account resource constraints, exogenous model control parameters should be mainly policy parameters.

There are the following areas of research related to the development of a methodological framework and a digital instrumental environment to support strategic decision-making on the innovation landscape. They provide such stages of innovation landscape strategic management:

- evaluation of individual projects and selection of optimal innovation structures for the implementation of innovation project (e.g., an intelligent information support system for innovation activities based on multi-agent approach);
- development of integrated indicators for assessing the innovation landscape (for example, a generalized indicator of innovation development of the economic system, based on a system of resource and functional indices that determine the innovation potential and innovation activity);
- methods of analysis and planning of local development on certain aspects of innovation landscape development (information, financial, personnel, criteria of infrastructure support, etc.).

To achieve the analytical goal, it is necessary to form a variable model of the innovation processes set impact on local sustainable development. The economic and mathematical models will expand the theoretical and methodological base and identify of local development factors, including the main indicators of the innovation landscape, explore their relationship in two interconnected systems “innovation landscape → sustainable development” and “sustainable development → innovation landscape” and develop a forecast system “local sustainable development” taking into account the innovation factor. The managing the innovation landscape as a process of long-term development planning begins with the forecasting of environment development. The environment in these areas largely formulates the requirements for development indicators, and hence the quality of the management system of innovation landscape

as a degree of compliance with these requirements. At this stage, a general forecast of the development of the innovation landscape for a certain period of time. Based on these requirements, the DSIP for innovation landscape analytics should include the following components:

1. Database of facts about innovation landscape (elemental composition, achieved innovation indicators).

2. Base of models for substantiation and decision-making in conditions of uncertainty at the stages of data analysis (current state of innovation landscape), selection of alternatives for innovation development, as well as assessment and forecasting the consequences of decisions. When creating decision-making models, one of the most important stages is the stage of constructing membership functions that describe the semantics of the basic values of the variables used in the model. To choose the methods the following requirements can be formulated:

- to create a model, it should be possible to formalize the information received from various actors in the decision-making process;
- this model should take into account the specifics of the factor of innovations development, described by sustainable development concepts.

3. Software subsystem that provides interaction between the system user and the database. It manages the creation, storage and recovery of models on a model basis and integrates them with the data in database.

For DSIP system for innovation activity evaluating a set of methods for evaluating innovation activity can be formed (Table 1).

TABLE I. METHODS FOR INNOVATION ACTIVITY EVALUATING

Evaluation aspect	Methods
Orientation of innovation activity of the enterprise on consumers	Methods of analysis of strategic development schemes, point-rating assessment, technical level map
The level of development of the innovation environment	Methods of detailed analysis, diagnostic assessments, complex qualimetric assessment
Level of process approach implementation	Method of performance evaluation
Level of system approach implementation	Methods of indicators balanced system, evaluation of relative effectiveness, evaluation of performed functions system
Dynamics of constant improvement	Method of estimation of constant improvements in system "costs - performed functions", dynamic indicators estimation, complex qualimetric estimation
Constructive decisions of innovation landscape development of the	Methods for evaluating of decision-making based on deterministic factor analysis, evaluating of decision-making based on performance indicators optimizing, evaluating of decision-making based on stochastic factor analysis
Level of interaction with contractors in the management of the innovation landscape	Method of evaluating the effectiveness of contacts

Source: author's generalization

Considering the innovation landscape as a complex

characteristic of innovation activity based on the receptivity to innovation, we can identify areas of implementation of DSIP.

#### IV. REGIONAL TECHNOLOGY TRANSFER

Innovation activity, both as a process and as a result, always has the properties of communicativeness, cannot exist and be realized without organizing systemic connections between the stages of its implementation.

The results of research [15] suggest that Digital Innovation Hubs (DIHs) despite their emerging and trial-and-error stage are designed for promoting multi-actor collaborative platforms including non-local actors to stimulate transition into Industry 4.0 by promoting place-based collaboration alliances that respond to local/regional contextual specificities and demands. These regional-based platforms facilitate public-private partnerships that co-design policy initiatives resulting from co-participation and negotiation of spatially-bounded oriented initiatives for digitizing. E.g., Navarra Region DIH started in 2016 with the name of «NAVARDMIHub». With the support of regional government in 2020, the DIH has evolved to «IRIS: European Digital Innovation Hub Navarra». The DIH aims to exploit the synergies and capabilities already organized in the regional innovation ecosystem, in terms of partners and capabilities promoting innovation, technology transfer, business creation, testing and experimentation, and training and dissemination for the digitalization [21]. Services provided by the Hub that summarizes their activities are the following:

- tailored training and talent: development of technology profiles to drive the digital transformation of businesses (access to degrees, masters and doctoral programs; data science laboratory; etc.); internationalization of talent related to digital transformation; scheme to attract international talent;
- consultancy: awareness raising and skills development; intervention by designing pathways and technology pathways for digitalization;
- R&D. Knowledge transfer: development of new products and processes; collection of information on your processes and production environment;
- experimental validation of the application of new technologies to products and processes;
- exchange of good practices: access to the technologies available in European Network of Digital Innovation Hubs and it is also a space to share experience and ideas;
- entrepreneurship: complete accompaniment program, facilitating the creation of new companies and the differentiation and drive of new projects;
- access to funding: private and public funding / regional, national and international funding.

We also believe that only the state's active involvement in creating of technology transfer centers

both at the legislative level and with the help of long-term financing can solve the problem of innovation processes intensification. State participation must also be manifested in tax support of companies that are involved in innovation retooling.

Another essential component deals with clear rules of state incentives of technology transfer. International technology transfer has long been one of the most profitable exports of countries like the USA, Japan, Israel and the UK. Leading American universities have been long engaged in developing and implementing high-tech products and technologies on orders of large businesses and public corporations for amounts that are measured in billions of dollars. This trend can also be seen in the development of European education and has become an essential indicator of university rating, its scientific potential, the requirements of accelerated social and economic development, and its competitiveness as a whole. It also determines its status in the formed global education market and innovation. In many universities in Germany and Poland, the income derived by scientists for teaching several times smaller than for research performance.

In the future, within the framework of practical implementation of the Quintuple Helix model, we propose to consider the project of the creation of a regional technology transfer network. Within the project, we propose establishing an innovation hub methodology designed to ensure communication and coordination of the regional economy's subsystems and external environment to achieve its strategic goals (Fig. 1). The network will carry broad interdisciplinary themes, which will be formed according to the development priorities and the authorities' participation.

In the future, we propose to change the organization form of the center to a closed joint-stock company, participants of which will include representatives of non-governmental organizations of innovation development and a regional consortium of research organizations (i.e. Multi-Institute Model). Regional administration will be a leading member of the coordination committee to ensure the public-private partnership principle's implementation. It will attract investment funds for project realization using a market-oriented entrepreneur strategy.

The main activities of the center (problem-oriented modules) considering the local level will include:

- 1) promotion the processes that will facilitate the technology transfer through licensing or establishing spin-off companies, development of methodological and information materials of technologies application;
- 2) problem solving of regional development with environmental and economic trends (development of measures for energy efficiency of different sectors);
- 3) implementation of projects according to the selected priorities (business planning) based on a cluster strategy;
- 4) looking for investors for the realization of high-tech projects and establish a private investment fund;
- 5) analytical functions (forecasting based on technology foresight methodology in regional

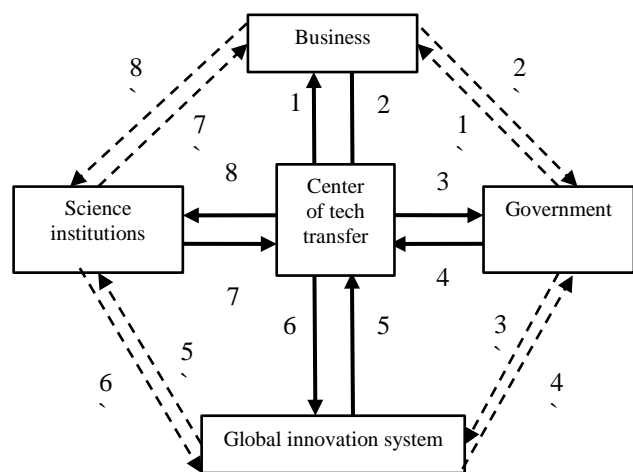
development, industry expertise of projects).

The main activities of the network will be:

1. Transfer of technology:

- use of methodologies such as Smart Up in the incubation of high-tech companies, venture capital projects offering the following model of cooperation: remuneration only after attracting investment in the project, the direction of the project on the attractive markets, preservation of capital, attracting cheap or "free" investments in the form of grants, SWOT-analysis of project, measures to strengthen the weaknesses of the project, development of geo-card possible further project;

- development of international cooperation in the area of transfer, attracting world-class experts for training, counseling and expert evaluation of projects;



**Centre's activities:**  
 1 - Technological audit and mapping of advanced technologies; 2 - proposal for technology transfer; 3 - Recommendations concerning priorities selection; 4 - support activities;  
 5 - monitoring; 6 - technology offers; 7 - proposals for cooperation; 8 - order for technologies  
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Figure 1. Scheme of the regional technology transfer network  
 Source: author's generalization

- creation of an e-portal of remote scientific advice is a cooperation of innovation business, which will differ from existing analogs;
- creation of Fabrication Laboratory for tech projects;
- integration of national research results to EU networks, information services, business cooperation and internationalization;
- creation of a center of collective using of research profile as a property complex (based on the material base of higher education or research partner organizations), which provides a mode of collective use of scientific and technological equipment of structural subdivisions of the primary organization and foreign users.

2. Ecological and economic problems: performance-contract methodology based on innovation energy efficiency technologies, based on the provision of services in complex practical energy-saving center with reimbursement of their costs and financial gain from the actual effect of activities.

Services in sustainable development spheres, based on DSIP, will consist of the following elements:

1. Basic services – services which are necessary for the development and implementation of an integrated project at customer facility from the initial technology audit through control savings estimation;

2. Integrated actions according to the needs of a particular object, which for example, can include analysis of energy efficiency, the potential of alternative energy sources, water treatment and applying of environmentally friendly materials and operations;

3. Project financing – the long-term financing of the project, provided by the third side of company financing;

4. Cluster strategy: selection and facilitate integration into international innovation clusters region actors, developing the concept of clusters innovation development, including constructing the list of target directions and development scenarios.

5. Analytical functions: service policy analysis in the innovation development context, creating the information environment and monitoring the real sector's needs.

## V. CONCLUSION

This research identifies new innovation practices, challenges and opportunities that arise for local managers along new innovation management trends based on digital component. Authors prove that analysis of innovation landscape requires the involvement of special knowledge in the field of economic and mathematical modeling of innovation processes within the sustainable development and the development of appropriate digital technologies.

The practical aspect of using digital tools in the innovation landscape is examined using the example of a regional technology transfer center. Its functioning is designed to ensure sustainable development of the region on an innovative basis through the provision of communications. The applied significance of developed model lies in the possibility of its application for the development of measures to improve innovation, both in individual regions and the country as a whole.

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## FOREWORD

The 44<sup>th</sup> International ICT Hybrid Convention MIPRO 2021 was held from September 27<sup>th</sup> to October 1<sup>st</sup>, 2021 in Opatija, Croatia. The Convention consisted of thirteen conferences under the titles: *Microelectronics, Electronics and Electronic Technology (MEET)*, *Data Science and Biomedical Engineering (DS-BE)*, *Telecommunications & Information (CTI)*, *Computers in Education (CE)*, *Computers in Technical Systems (CTS)*, *Intelligent Systems (CIS)*, *Robotics Technologies and Applications (RTA)*, *Information Systems Security (ISS)*, *Business Intelligence Systems (miproBIS)*, *Digital Economy and Digital Society (DE-DS)*, *Information and Communication Technology Law (ICTLAW)*, *Engineering Education (EE)* and *Software and Systems Engineering (SSE)*. An additional conference was dedicated to the works of students: *MIPRO Junior-Student Papers (SP)* and there was one special session: *Optoelectronics and Photonics (OPHO)*.

This comprehensive Book of Proceedings includes all positively reviewed and presented papers from each of these conferences. All the papers were reviewed by an International review board and the list of reviewers is contained in the Book of Proceedings. These papers were written by the authors from universities, scientific institutions, educational institutions, industry and other participants.

The convention was organized by the Croatian ICT Society MIPRO with the help of numerous patrons and sponsors to whom we owe our sincere thanks. We especially single out our general sponsor Hrvatska elektroprivreda along with golden sponsor Končar - Electrical Industry and bronze sponsors Storm Computers, Ericsson Nikola Tesla, Siemens Energy and Infodom.

To all who helped organizing the 44<sup>th</sup> International ICT Hybrid Convention *MIPRO 2021* as well as editing of this Book of Proceedings we extend our heartfelt thanks.

Academician Karolj Skala, PhD  
International Program Committee  
General Chair