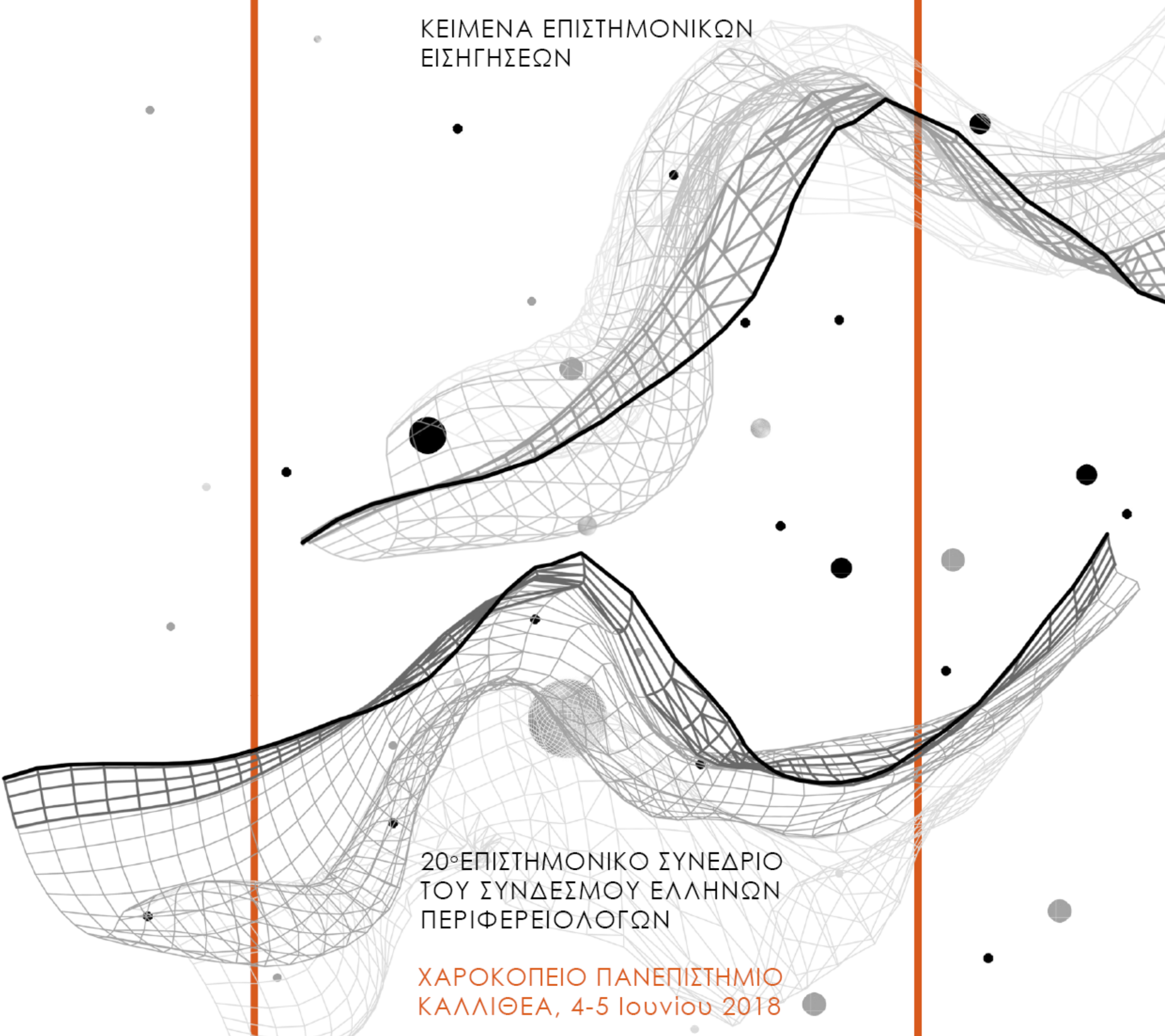
Η ΠΕΡΙΦΕΡΕΙΑ ΣΕ ΚΑΜΠΗ

ΜΕΤΑ-ΨΗΦΙΑΚΕΣ ΚΟΙΝΟΤΗΤΕΣ, ΝΕΟΣ ΤΟΠΙΚΙΣΜΟΣ ΚΑΙ ΕΠΑΝΕΘΝΙΚΟΠΟΙΗΣΗ – ΑΝΑΠΤΥΞΙΑΚΕΣ ΠΡΟΕΚΤΑΣΕΙΣ | REGIONS AT A TURNING POINT: POST-DIGITAL COMMUNITIES, NEW REGIONALISM AND RE-NATIONALISATION – SUSTAINABLE DEVELOPMENT IMPLICATIONS

ΚΕΙΜΕΝΑ ΕΠΙΣΤΗΜΟΝΙΚΩΝ ΕΙΣΗΓΗΣΕΩΝ



20ο ΕΠΙΣΤΗΜΟΝΙΚΟ ΣΥΝΕΔΡΙΟ ΤΟΥ ΣΥΝΔΕΣΜΟΥ ΕΛΛΗΝΩΝ ΠΕΡΙΦΕΡΕΙΟΛΟΓΩΝ

ΧΑΡΟΚΟΠΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ
ΚΑΛΛΙΘΕΑ, 4-5 Ιουνίου 2018

συνδιοργάνωση

Χαροκόπειο Πανεπιστήμιο

ΣΥΝΔΕΣΜΟΣ ΕΛΛΗΝΩΝ ΠΕΡΙΦΕΡΕΙΟΛΟΓΩΝ
ΕΤΟΣ ΙΔΡΥΣΗΣ 1979

Internet platforms, innovation and growth under the 'smart everything' paradigm

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Abstract

The paper discusses the conditions that allow diverse phenomena such as 'smart growth', 'smart specialisation', 'smart cities', and 'smart communities' to be considered as constituting components of the 'smart everything' paradigm. We look at the features of the smart everything paradigm and how it relates to this group of concepts that describe the current dynamics and policies of development. We argue that the unifying condition allowing such diverse phenomena to be aggregated under the 'smart everything' paradigm is the creation of cyber-physical systems of innovation, based on Internet and world-wide-web platforms that orchestrate disruptive innovations, social innovations, and eco-innovations. The paper concludes with some modifications in the knowledge-based development theory that derive from the smart everything paradigm and the wide use of Internet platforms to sustain collaboration, awareness, and growth.

Keywords: Smart growth, Smart specialisation, Smart cities, Internet platforms, Innovation, Cyber-physical systems of innovation.

1. Introduction

Over the last few years a group of new concepts attempts to describe the dynamics and policies of development in Europe, the US, and elsewhere: *smart growth*, a core component of the EU 2020 strategy; *smart specialisation*, the current European research and innovation strategy; *smart communities*, the European Innovation Partnership that brings together cities, industry and citizens for collaboration; *smart cities*, a term used widely in numerous localities all over the world for new solutions in urban governance by interactive environments. These concepts gather a lot of attention in urban and regional development agendas and constitute manifestation of a wider trend that Streitz (2017) has coined under the term of the 'smart everything' paradigm. This paradigm, which is created by the convergence of knowledge-based development, smart technologies, the Internet of Things, data analytics and ambient intelligence, outlines a new direction in urban and regional development, namely growth over knowledge platforms (Oskam and Boswick, 2016; Srnicek, 2016).

The topic of the paper is the underlying condition that allows congregating divers phenomena, such as 'smart growth', 'smart specialisation', 'smart cities', and 'smart communities', under the 'smart everything' paradigm. We argue this is not a nominal condition, deriving from the use of the attribute 'smart' in figurative than literal meaning. On the contrary, the unifying condition is related to a fundamental change in our problem-solving capability, emerging from Internet technologies and intelligent spaces that enable knowledge diffusion, collaboration and innovation in the framework of digital communities. The underlying condition of the smart everything paradigm, uniting smart growth, smart specialisation and smart communities, is the creation of cyber-physical systems of innovation and the wide use of Internet platforms and community spaces to generate innovation for growth, social cohesion, and sustainability.

2. The 'smart everything' paradigm

The 'smart everything' paradigm is fuelled and gains momentum from the most important technology stack of our era, the combined technologies of Internet, World Wide Web, and data science. These collaborative technologies pave the way to a wider array of technologies, such as cloud computing, sensor networks, cyber-physical systems, artificial intelligence and augmented reality. Altogether, they push human collaboration and user-driven innovation to higher levels of efficiency and scale. The 'smart' attribute advocates innovativeness, participation, collaboration and coordination within a rationale of network-based relationships (Antonelli and Cappiello, 2016). It highlights also evidence-based approaches in policy and strategic planning, in which big datasets, pilot experimentation and continuous assessment drive decision-making.

The features of the 'smart everything' paradigm take flesh and become feasible thanks to multiple forms of digital disruption and collaborative innovation. These include, among others, global information flows and easiness of collaboration across continents and time zones; large-scale user engagement in various domains of activity over crowdsourcing platforms; participatory data creation, big datasets and analytics; global innovation supply chains; the rise of a sharing economy; and new modes of production, such as demand-driven production, distributed collaborative production, customer co-production, and other forms of network-based work and exchange. In this paradigm, physical objects of everyday life are equipped with sensing and communication capabilities, can perceive their state and interact with other objects and the environment. The embedded processing power into smart objects enables a series of control functions, such as scheduling and status update, switch on and off operations with respect to changing conditions, alert in cases of events. Devices can exchange data and make autonomous decisions based on preset conditions. Smart objects and machines interact with other objects, but also with the environment and humans.

In the world of smart objects and the Internet of Things, the 'Ambient Intelligence' approach connects smart environments with user-oriented design, the interaction of humans with technology, and the social context of data and communication. According to Norbert Streitz (2017, p. 2) "*Ambient Intelligence represents a vision of the (not too far) future where "intelligent" or "smart" environments and systems react in an attentive, adaptive, and active (sometimes even proactive) way to the presence and activities of humans and objects in order to provide intelligent/ smart services to the inhabitants of these environments. Ambient Intelligence technologies integrate sensing capabilities, processing power, reasoning mechanisms, networking facilities, applications and services, digital content, and actuating capabilities distributed in the surrounding environment.*" The combined capabilities, generated by smart objects, smart environments and user engagement, can address many economic, environmental and societal challenges, and are increasingly used in manufacturing, logistics, energy, transportation, healthcare, safety and security.

In this interconnected world, Internet platforms, web-applications, smart objects, data analytics, user engagement and crowdsourcing, sustain various domains of contemporary life: the smart growth agenda, the evidence-based policies of smart specialisation, systems and solutions for smart cities and communities.

Smart growth is a key dimension of the current European strategy for sustainable development. As core component of EU2020 strategy it encourages education, learning and improvement of skills; innovation in products, services and modes of operation; and the deployment of information technologies to strength collaboration and the provision of online services. It has institutionalised 'Research and Innovation Strategies for Smart Specialisation' as ex-ante conditionality for getting ERDF funds and promotes also strategies for next generation broadband networks and Digital Transformation Strategies to make cities more productive, liveable, and innovative.

Conceptually, smart growth is characterised by three trends: (1) the centrality of technological innovation, the Internet and the world-wide-web, (2) networks that connect digital infrastructure with human skills, institutions, and physical spaces, and (3) bottom-up, user engagement, co-design and collaboration (Antonelli and Cappiello, 2016).

Productive differentiation is also a key factor for smart growth. The discovery of 'variety' as factor of knowledge-based growth led to an advancement in the theory of urban and regional development, namely the formation of the related /unrelated variety approach. There is evidence that knowledge spillovers, a core driver of knowledge-based development, are not due to spatial proximity and agglomeration only, but to technological and cognitive proximity as well. Boschma (2005) described other forms of proximity that affect knowledge sharing and spillovers, such as organizational, social, and institutional proximity. Antonelli and Leoncini (2016) argued that smart development should recognize the role of cities as fly-wheels of development, and define regional specialisations by contiguous industrial sectors for the development of local systems. These might be industrial sectors having complementary characteristics and cognitive proximity, thus exhibiting related than unrelated variety.

The smart specialisation agenda, a central pillar of the EU smart growth strategy for the period 2014-2020, is also instituted on similar ideas. "*Smart specialisation, is a process of priority-*

setting in national and regional research and innovation strategies in order to build "place-based" competitive advantages and help regions and countries develop an innovation-driven economic transformation agenda" (Landabaso 2014b, p. 378). Smart specialisation strategies (S3) reject the 'one-size fits all' approach as a common growth trajectory for all regions (Tödtling and Trippl, 2005). Contrary to a common development path, S3 focus on assets and strengths specific to each region, which drive the policy mix and actions creating regional competitive advantages.

Evidence-based policy, participatory governance, entrepreneurial discovery, trans-industry specialisation, public-private partnership, R&D and technology actions for industry diversification, are fundamental concepts of smart specialisation thinking (Landabaso, 2014a). S3 follows a process of discovery and innovation, "choosing races and placing bets rather than picking the winners" (McCann, 2015). Consequently, strategy should be informed and guided by data and evidence appropriate to context, and outcomes should be monitored and evaluated by metrics and indexes. Participatory decision-making, entrepreneurial leadership, and datasets, are essential features of the smart RIS3 place-based approach.

As a strategic planning approach, S3 defines a policy mix composed of research and innovation actions for industry modernisation and diversification and offer an innovation-friendly business environment. This presuppose a better understanding of two critical dimensions of innovation support environments: first, recognize the collective nature of individual productivity, which does not depend on individual talent and effort only, but is the result of collective endeavours and efficient systems of innovation (Kakderi, 2014); second, realise that innovation-friendly business environments are place-specific, shaped by path-dependent trajectories of countries and regions. Therefore, innovation actions of S3 face a double challenge: develop research and innovation infrastructure and key-enabling technologies as drivers of industry diversification; and make these technologies available to selected productive activities of a region (Komninos *et al*, 2014).

Business leadership and entrepreneurial discovery, which are important elements of the smart specialisation agenda, define also the limitations of this approach. Growth based on technological innovation, industrial modernisation, branching and diversification, is a high priority in the business community. But, this is less pertinent for social innovation and its collective objectives and for eco-innovation for renewable energy and efficient energy, and optimisation of water and waste systems. In these fields, the smart city agenda seems better suited to address challenges related to environmental sustainability, quality of life, safety and security, and participatory governance.

Smart cities bring-in the promise to address effectively challenges of sustainability, climate change, safety and quality of life in cities, by introducting more efficient use of resources and more intelligent systems of decision-making. Smart cities offer hundreds of solutions that enable human communities to improve their economy, infrastructures and utilities, the environment, and living conditions. The urban system, in all its dimensions and planning, is optimised by using big datasets and network linkages. The city becomes a measurable and transparent system and city planning a quantitative than qualitative discipline.

The academic establishment of the smart city as a new city planning and development model has been very rapid (Mora *et al*, 2017). Within 15 years, the annual Google Scholar yield of publications in this field (search for 'smart city(ies)' and 'intelligent city(ies)') increased by 130 times and from 148 publications in 2001 reached 19,013 in 2017. The number of publications of this field becomes even larger if we consider other terms under which smart places and environments are discussed, such as 'digital city', 'cyber city', 'ubiquitous city' and 'urban informatics'.

The above agendas of 'smart growth', 'smart specialisation' and 'smart city' outline three instances of the 'smart everything' paradigm, as interdisciplinary field of science and technology, where urban and regional development, planning and management sciences, economic geography, innovation studies, information technologies and data science converge. Altogether they form the field of an emerging mega-science, which brings together scientists, theories and methods from many disciplines to study the grand challenges of our time and devise solutions by Internet technologies, disruptive and social innovations. Interdisciplinarity is dominant in this field, and the spectacular increase of publications, which is observed, is due to numerous academic disciplines that produce this intellectual outcome.

3. Three experiments of smartness by Internet platforms

During the last five years, we were involved in three research experiments under the FP7 projects 'People' and 'Storm-Clouds' and the H2020 project 'Online S3'. These cases reveal inter-dependencies and common features among the above-mentioned components of the Smart Everything Paradigm in the use of Internet, web platforms, and datasets for growth, innovation, and governance.

The first experiment concerned a web platform and datasets that facilitate socio-technical and business management in smart growth and smart specialisation initiatives (Panori *et al*, 2018). The second concerned digital platforms and web-based tools allowing citizen participation in collaborative innovation activities, ranging from policy design and implementation to solving everyday life problems (Kakderi *et al*, 2018). The third experiment was about Internet platforms for participatory governance and sustainable development, enabling public authorities to establish new communication channels for engaging citizens, organisations and companies in local governance (Tsarchopoulos *et al*, 2018).

There is a common ground in the way new solutions were produced in these cases by the convergence of digital technologies, user engagement, and collaboration networks. Smart growth was sustained by innovation, and information technologies and various kinds of digital disruptions; smart specialisation strategies were driven by insights of entrepreneurial discovery and evidence-based policies; and smart cities relied on platforms for social innovation and eco-innovation. In all cases, 'smartness' derived from cyber-physical systems of innovation, and innovations produced over physical, social, institutional and digital spaces.

4. Cyber-physical systems of innovation

Cyber-physical systems of innovation (CPSI) appear from merging innovation networks, on the one hand, with Internet networks and the information flows of the World-Wide-Web, on the other. Due to this connection, innovation becomes more open and inclusive, available to all and attainable by all. The general form of a cyber-physical system of innovation is a supply chain connecting nodes of R&D, financiers, market makers, producers, technology intermediaries, and policy makers. Each node of the network is also a network with physical, institutional, digital entities. Some key features of CPSIs are:

- *Multiplication of innovation actors and nodes* with the involvement of remote actors and virtual actors from around the world. The number of 'actants' in the system rises geometrically as many suppliers and users can connect virtually and undertake innovation tasks.
- *Spread of digital identities* due to augmented reality and the Internet of Things, which makes all objects (new products and services) hybrid, combining a physical and a digital identity.
- *Co-creation* in product or service design, and consumers turning to mediators of concept-development and in some cases co-producers of innovation.
- *Rapid new product launch*, creation of prototypes as early as possible; releasing early and often; gathering usage data and giving feedback into product design as often as possible; outsourcing whatever can be found elsewhere.
- *Open intellectual property* (IP) or innovation without IP, via free and open licenses. Commons-oriented licenses creating goods that can be used universally, sharing licenses, and allowing the use of whatever is placed on commons and open platforms.

These features of CPSIs fertilise new forms of innovation, organised by Internet and web-based platforms, which provide with data, digital access to markets, opportunities for collaboration and making and other knowledge externalities. Internet platforms sustaining innovations appear under various forms, as collaboration platforms in business ecosystems, new generation broadband networks, intangible infrastructures and commons, and crowdsourcing platforms. Oskam and Boswijk (2016) developed a typology of such platforms by the intersection of two axes: (1) open access vs. controlled access, and (2) platforms for benefit vs. platforms for profit. Four types of Internet platforms derive, corresponding to 'network capitalism platforms', 'P2P market places', 'commons', and 'cooperative platforms'.

From the perspective of innovation, there is an association between shared platforms that enable disruptive innovations; community spaces enabling social innovations; and awareness spaces enabling eco-innovations. Each type of Internet/web platform enables a different kind of innovation.

Shared platforms connect people in collaborative production, collaborative consumption, collaborative learning, and collaborative finance. Peers collaborate over the platform in design, making, and distributing goods. Such forms of collaborative economy or hyperconnected economy (Rifkin, 2014) are expanding to many industries, particularly the services sectors of transport, hospitality, real estate, insurance, software, telecommunications, and energy. They allow swarms of small businesses and individuals to cluster on the platform and create cumulative downstream critical mass of skills and entrepreneurship. According to Srnicek (2016), shared platforms have four main features: they are digital infrastructures that enable user to interact; rely and thrive on network effects; use cross-subsidisation by offering free products and services; and deploy user engagement through presentations of their offerings. Due to platform or network effect, shared platforms sustain *disruptive innovations,* which gradually obtain critical mass and disrupt many sectors of the economy. A disruptive innovation describes a process whereby a smaller company with fewer resources can successfully challenge established incumbent businesses. Platforms and their modular structure enable businesses to innovate more efficiently and engage with communities of innovators developing complementary products and services (Christensen *et al*, 2016). The result is a flourishing of business over business ecosystem; each connected business managing its own value chain; consumers turning to co-creators of value; and an expanding consumer-driven production.

Community spaces and commons enable another kind of innovation. They create digital spaces that aggregate assets from a community (information, moneys, goods and services) which are offered by members of the community. They are open and free for use by members or non-members of the community. Due to community effect, such platforms are well suited to sustain *social innovations* that resolve social and inequality challenges for the benefit of a group of people or the community as a whole. Activities of participatory governance, crime and aggression mapping, social care, community safety and security can be supported by this kind of platforms. Community spaces correspond to 'commons' in the typology of Oskam and Boswijk (2016) and work for the public good, having the public benefit as central objective and no other reward than the creation of value. User engagement and operation for benefit than for profit are their main features. The engagement of users and the offer of resources is guided by social objectives, the culture of belonging to a community, and motivation for sharing with others.

Awareness spaces are digital platforms that enable a better understanding of the environment, its challenges, and mapping of resources. With the advance of urbanisation, the need to reduce the use of fossil fuels and CO2 emissions has become a central objective of sustainable development. But the road towards sustainability passes from awareness and establishing emissions inventories that track CO2 emissions and their sources. In parallel, the use of sensors grows in all sectors of utilities, and smart systems become mainstream in the domains of energy, water, waste, and transport. Smart energy systems merge the electricity, heating, and transport sectors to reduce primary energy spending and emissions (Mathiesen *et al*, 2015). Awareness spaces and platforms integrate information from diverse sources and offer a comprehensive view of pollutants, making them entry point for eco and green innovation.

Cyber-physical systems of innovation and the different types of Internet platforms they create shape the current innovation landscape, both in terms of innovation processes and innovation policy. In the supply side, CPSIs offer cost-saving solutions, online testing environments, hybrid supplier networks, and datasets and digital assistants for informed decision-making. In the demand side, they enable the engagement of users and consumers by real-time solutions and online markets from around the world. With these features, CPSIs are placed at the core of the emerging smart everything / smart city paradigm.

5. Modifications of the knowledge-based growth theory

Since 1990, growth theory is dominated by 'evolutionary economic theory', 'evolutionary economic geography' and 'new growth theory', which redefine the growth-enhancing forces, putting knowledge, technology and innovation at the centre of growth. In the new growth theory for instance, central notion is increasing returns, associated with knowledge or technology. Due to increasing returns, knowledge offers opportunities for unlimited growth. Knowledge is subject to increasing returns because it is a non-rival good; it improves by the use, while the opposite happens with physical goods that are consumed and diminish by the use (Cortright, 2001). From an evolutionary economic geography perspective, 'smartness' drives the growth of industries, as long as the behaviour of firms is guided by routines and market competition together with funding institutions act as selection mechanisms, causing 'smart' fit routines to diffuse and 'stupid' unfit routines to disappear" (Boschma and Frenken, 2006).

The spread of Internet platforms and the digital spatiality of shared platforms, community spaces and commons, and awareness spaces, transform some key areas of knowledge-based growth theories, by introducing attributes of physical-digital dimension.

First, in the dynamics of growth, *new externalities* are created by smart environments and digital commons. This trend conveys the growth problem from start-ups and the increase of independent knowledge-intensive businesses to the growth of swarms of companies and business ecosystems connected over Internet platforms by information and knowledge externalities. User-driven innovation and consumer-driven production are instances of this platform-based ecosystem growth.

Second, the divide between *private goods* (which are excludable and rival) and *public goods* (which are non-excludable and non-rival) is redefined. Platforms stand between excludable goods and non-rival goods. They are open to producers at zero cost. The platform development and maintenance costs are transferred to consumer, paid at the reception of a service hosted on the platform. Other platforms, such as commons and awareness platforms are full non-excludable and non-rival goods.

Third, growth over platforms can be progress without *intellectual property rights* and restrictions of patents, trademarks and copyright law. The competitiveness of the platform is based on size and critical mass than intellectual property. The competitiveness of the businesses that populate the platform ecosystem is based on network effect than propriety knowledge.

Altogether, Internet and world-wide-web platforms and the associated cyber-physical systems of innovation strengthen problem-solving by openness, awareness, and sharing, which become fundamental features of innovation and growth under the smart everything paradigm.

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Διαδικτυακές πλατφόρμες, καινοτομία και ανάπτυξη στο υπόδειγμα ευφυΐας των πάντων

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Περίληψη

Κατά τη διάρκεια των τελευταίων ετών μια ομάδα νέων εννοιών επιχειρεί να περιγράψει τη δυναμική και τις πολιτικές ανάπτυξης. Πρόκειται για έννοιες όπως «έξυπνη ανάπτυξη» ως βασική συνιστώσα της στρατηγικής ΕΕ-2020, «έξυπνη εξειδίκευση» ως νέα περιφερειακή πολιτική έρευνας και καινοτομίας, «έξυπνες κοινότητες» ως συμπράξεις καινοτομίας που κατευθύνεται από τους χρήστες, και «έξυπνες πόλεις» για διακυβέρνηση και ανάπτυξη με διαδραστικά περιβάλλοντα, που αποτελούν εκφάνσεις ενός υποδείγματος «ευφυΐας των πάντων» (smart everything). Το άρθρο εξετάζει τα χαρακτηριστικά του παραδείγματος αυτού και πώς συνδέονται με την ομάδα εννοιών που περιγράφουν τη σύγχρονη δυναμική της ανάπτυξης. Υποστηρίζουμε ότι η ενοποιητική συνθήκη που επιτρέπει διαφορετικές εκφάνσεις του 'smart' να τεθούν κάτω από το ίδιο υπόδειγμα βασίζεται στη δημιουργία φυσικο-ψηφιακών συστημάτων καινοτομίας, καθώς και στη χρήση διαδικτυακών πλατφορμών που υποστηρίζουν την αποδιαρθρωτική, κοινωνική και οικο-καινοτομία. Το άρθρο καταλήγει σε κάποιες τροποποιήσεις στη θεωρία ανάπτυξης που βασίζεται στη γνώση, οι οποίες απορρέουν από την ευρεία χρήση πλατφορμών του διαδικτύου.

Λέξεις κλειδιά: Έξυπνη ανάπτυξη, Έξυπνη εξειδίκευση, Έξυπνες πόλεις, Πλατφόρμες διαδικτύου, Καινοτομία, Φυσικο-ψηφιακά συστήματα καινοτομίας.