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SMART, CONNECTED PRODUCTS AS A NEW COMPETITIVE ADVANTAGE: CHALLENGES FOR SERBIA*

Pametni povezani proizvodi kao nova konkurentna prednost – izazovi za Srbiju

Abstract

The current debate among scholars of innovation and competitiveness centres on the concept of smart connected products (SCP). In this review article, we attempt to engage Serbia in this global debate by explaining the core concepts and arguments, building on previous research, and demonstrating how the developments in Serbia's ICT sector exemplify the new theory. We present the cases of three companies engaged in the production of SCPs, namely Schneider Electric DMS NS, Strawberry Energy, and Bitgear. Whilst the bulk of the IT production and exports volume in Serbia can be ascribed to outsourced, general software programming, these case studies are evidence of future potential of SCP (or Internet of Things) development. For more companies to specialise and successfully compete at the global level, additional, principally foreign investment in the sector is required. The key limitation here, in addition to the deficiencies in the business climate, is the availability of quality human resources, which calls for increased public funding of education in the relevant ICT skills, a more comprehensive reform of research and innovation infrastructure and gearing publicly available funding for innovation principally via institutions like the Innovation Fund, which is functioning based on best international practices.

Keywords: *innovations, competitiveness, smart connected products, Internet of Things, ICT, Serbia*

Sažetak

Aktuelna akademska rasprava u oblasti inovacija i konkurentnosti posebno se bavi pojmom pametnih povezanih proizvoda (PPP). U ovom preglednom radu nastojimo da uključimo Srbiju u ovu globalnu debatu, objašnjavajući glavne koncepte i argumente, nadovezujući se na prethodna istraživanja i pokazujući kako razvoj sektora IKT u Srbiji predstavlja primer primene ove teorije u praksi. Predstavljamo slučajeve tri preduzeća koja prave PPP, a to su *Schneider Electric DMS NS*, *Strawberry Energy* i *Bitgear*. Iako većina proizvodnje i izvoza IT može da se pripíše podugovaranju i standardnom programiranju, ovi slučajevi ukazuju na potencijal razvoja PPP (odnosno proizvoda koje se nazivaju i Internet stvari). Da bi se više preduzeća usavršilo i uspešno takmčilo u svetu, potrebne su dodatne, primarno strane investicije u ovaj sektor. Ključno ograničenje, pored nedostataka poslovne klime, predstavlja ograničena ponuda kvalitetnih kadrova, što zahteva veća ulaganja države u obrazovanje u kompetencijama koje su potrebne sektoru IKT, sveobuhvatnu reformu infrastrukture za istraživanje i inovacije, i usmeravanje javnih sredstava za inovacije kroz institucije poput Inovacionog fonda, koji prati najbolje međunarodne prakse.

Ključne reči: *inovacije, konkurentnost, pametni povezani proizvodi, Internet stvari, IKT, Srbija*

* This article was produced as part of the research project "Advancing Serbia's Competitiveness in the Process of EU Accession", no. 47028, during the period 2011-2015, supported by the Serbian Ministry of Education, Science and Technological Development.

Introduction: Innovation as key driver of competitiveness and economic development

The current debate among scholars of innovation and competitiveness centres on the concept of smart connected products (SCP). In this review article, we attempt to engage Serbia in this global debate by explaining the core concepts and arguments, building on previous research, and demonstrating how the developments in Serbia's ICT sector exemplify the new theory.

The period of financial and wider global economic crisis that emerged in 2008 has brought a new focus in economic literature relating to the significance of microeconomic factors as enablers of sustainable economic growth. A consensus has emerged in relation to innovation representing a critical factor in accelerating economic development [22], [3], [4]. Continuing our research on advancing Serbia's competitiveness by employing industry clusters and creative industries, and the relevant innovation processes as engines of development [31], based on Porter's competitiveness model [9], we hereby turn to Christensen's theory of disruptive innovations [2]. A disruptive innovation, according to *Christensen et al.*, is an innovation that helps create a new market and value network, and that eventually disrupts the existing market and value network replacing earlier technologies (in a period ranging from a few years or decades). The term is used in business and technology literature to describe innovations that improve products and services in ways not expected by the market (e.g. by creating different positions for consumers in new markets or by lowering prices in existing markets).

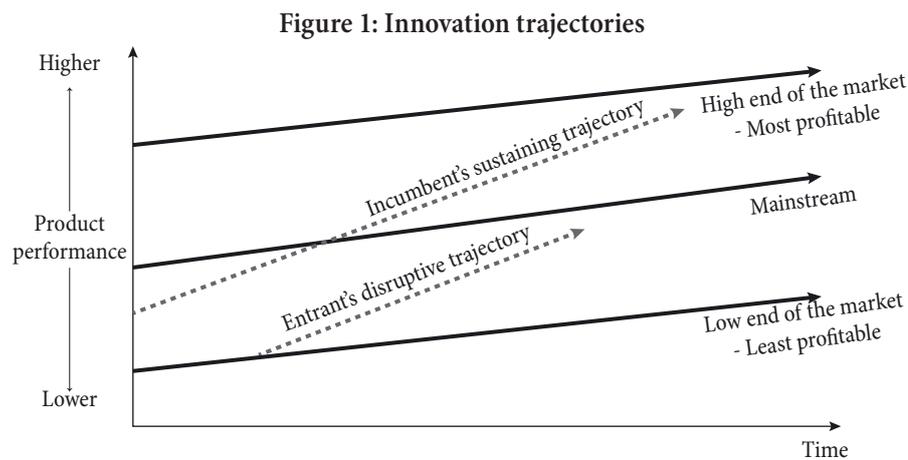
In contrast to disruptive innovation, a sustaining innovation does not create new markets or value networks, but rather enhances the value of existing markets and networks, enabling firms to compete against each other's sustaining improvements. Sustaining innovations may be either discontinuous (i.e. transformational or revolutionary) or continuous (i.e. evolutionary). According to Christensen's theory the three enablers of disruptive innovation are: (i) simplification of technology, (ii) business model innovation (simplified solutions for interested customers) and (iii) embedding solutions into a new value network (customers,

distribution, suppliers). A disruptive (or empowering) innovation creates a base for new employment. A sustaining innovation is highly significant but, due to its nature, does not generate new employment. Such innovations render a good product better. When customers buy the new product with sustained innovation, they usually no longer purchase the old product.

To ensure a full understanding of disruptive innovations, *Christensen et al.* have outlined the elements that are required to describe a certain innovation as disruptive [5, pp. 48-50]:

- (i) Disruption is a process: common mistakes include failing to view disruption as a gradual process (may lead incumbents to ignore significant threats) and blindly accepting the "Disrupt or be disrupted" mantra (may lead incumbents to jeopardize their core business as they try to defend against disruptive competitors); almost all innovations, be their disruptive or not, start as small experiments, and disrupters focus on a successful business model, and not just the product;
- (ii) Disrupters establish business models that are significantly different from those of incumbents, as exemplified by Apple's sustaining innovation in 2007 in the smartphone market whereby the phone replaced certain functions of a computer;
- (iii) Not all disruptive innovations succeed;
- (iv) The mantra "Disrupt or be disrupted" may be misleading; incumbent companies should react to disruption but not by dismantling a profitable business – instead they should strengthen relationships with core customers by investing in sustaining innovations.

Christensen, Raynor & Donald [5, p. 49] explain that disrupters often start at the low end of underserved customers and then migrate to the mainstream market. Figure 1 illustrates the concept of disruptive innovation by projecting two innovation trajectories: the first, indicating product performance (shown as dotted lines) illustrates how products improve over time and the second, representing customer demand (shown as solid lines) depicts customers' willingness to pay for performance. When incumbent companies introduce higher quality



Source: [5]

products (upper dotted line) to satisfy the high end of the market (where profitability is highest), they tend to exceed the needs of low-end customers and many mainstream customers, opening up the market for entrants in that market segment. Entrants on a disruptive trajectory (lower dotted line) improve performance and thereby challenge the incumbents, moving upmarket.

Florida [12, p. 21] further accentuates human creativity as the key determinant of economic activity. Creativity has become a value as the principle generator of new technologies, new industries and new wealth. *Florida* has identified a new economic class, a *creative class* that will dominate the economic and cultural life of this century just as the working class dominated in the early 20th century and the service class over the past decades. Although the creative class is not as massive in numbers like the service class, it is an agent of growth and change in the economy and society. *Florida* [14] argues that the current crisis is more than a financial or economic crisis, founded on a deep structural divide between productive and innovative capacities of the emergent knowledge-based creative economies, on one hand, and the outmoded institutions, economic and social structures and geographic forms of the old industrial age, on the other hand. *Potts* [27] also calls creative industries the main agent of economic modernization. The primary economic value of creative industries lies in the affirmation and expansion of innovation during economic evolution, emphasizing the importance of creative clusters and innovations and confirming Porter's concept of linking

agglomeration and innovation [21], [23]. Just as factories were the primary economic institutions in the industrial era, schools and universities are becoming the primary economic institutions in the era of innovation. As *Florida* [13] points out, the highest paid workers today are those who belong to the creative class.

In a recently published article, *Martin, Florida & others* [18] have linked Michael Porter's industrial cluster theory to Richard Florida's occupational approach of creative and routine workers in order to gain a better understanding of the process of economic development. In combining these two approaches, they have identified four major industrial-occupational categories: creative-in-traded, creative-in-local, routine-in-traded and routine-in-local clusters. They found that economic development is positively related to employment in the creative-in-traded category.

New competitive advantage based on smart connected products (SCPs)

Porter & Heppelmann [25] have argued that there have been three waves of Information Technology (IT)-driven competition, which radically reshaped competition in the past 50 years. The first wave of IT development, during the 1960s and 1970s, automated individual activities in the value chain, ranging from order processing and bill payment to computer-aided design and manufacturing resource planning. The rise of the Internet marks the second wave of IT-driven transformation in the 1980s and

1990s. The Internet enabled coordination and integration across individual activities, market actors and it increased the potential geographic reach. The first two waves gave rise to immense productivity gains and growth across the economy. Nonetheless, while the value chain was transformed, products themselves were relatively unaffected. Now, in the third wave, IT is becoming an integral part of the product. The smart, connected products (SCPs) have been enabled by vast technological improvements in processing power, device size and design, as well as ubiquitous wireless connectivity. These products are transcending industry boundaries, disrupting value chains, altering industry structure, which raises a new set of strategic choices for competitors and facilitates further innovation, and hence economic growth.

The SCPs are often also described under the umbrella of another concept, “Internet of Things (IoT)”, defined as “a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies” by the International Telecommunications Union Global Standards Initiative on Internet of Things [15]. IoT implies network of physical objects – devices, vehicles, buildings and other items, which are embedded with electronics, software, sensors, and network connectivity that enable these objects to collect and exchange data. It is both a method to ensure a higher productivity and a vision with technological and societal implications. *Kevin Ashton*, co-founder of Auto-ID Center, initially coined the term, during a presentation made at Procter & Gamble in 1999 (Ashton, 2009), at the time linking frequency identification (RFID) to the Internet to improve business models. Development of the concept and business model grounded upon what are today known as smart devices, has been facilitated by both scholars and entrepreneurs, starting as early as 1982 at Carnegie Mellon University, and evolving further in 1990s (see [37], [28]).

Porter & Heppelmann [25] have taken the IoT concept further and discussed it in the light of strategic decision-making process with the aim of achieving and maintaining market competitiveness. They ascribe three core elements to smart connected products that are essentially enabled by IoT:

- (i) physical components comprise the mechanical and electrical parts of product;
- (ii) “smart” components comprise the sensors, micro-processors, data storage, controls, software, and, typically, an embedded operating system and enhanced user interface;
- (iii) connectivity components comprise the ports, antennae, and protocols enabling wired or wireless connections with the product.

Importantly, connectivity serves a dual purpose: (i) exchanging information between the product and its operating environment, its maker, its users, and other products and systems and (ii) enabling some functions of the product to exist outside the physical device [25].

Porter [24] has famously argued that in any industry, competition is driven by following five competitive forces: the bargaining power of buyers, the nature and intensity of the rivalry among existing competitors, the threat of new entrants, the threat of substitute products or services, and the bargaining power of suppliers. The composition and strength of these forces collectively determine the nature of industry competition and the average profitability for incumbent competitors. Industry structure changes when new technology, customer needs, or other factors shift these five forces. SCPs shift many industries in a way that may be even more palpable than the previous wave of Internet-enabled services, and the greatest effect may be in manufacturing. *Porter & Heppelmann* [26] define the following effects of SCPs, described within the five competitive forces model framework:

- (i) Bargaining power of buyers – SCPs dramatically expand opportunities for product differentiation, moving competition away from price alone; obtained data how customers actually use the products enhances a company’s ability to segment customers, customize products, set prices to better capture value, and extend value-added services; SCPs serve to mitigate or reduce buyers’ bargaining power;
- (ii) Rivalry among competitors – SCPs have the potential to shift rivalry, opening up numerous new avenues for differentiation and value-added services; these products also create opportunities to

broaden the value proposition, to include valuable data and enhanced service offerings; offsetting this shift in rivalry away from price is the migration of the cost structure of SCPs toward higher fixed costs and lower variable costs;

- (iii) Threat of new entrants – New entrants in a smart, connected world face significant new obstacles, starting with the high fixed costs of more-complex product design, embedded technology, and multiple layers of new IT infrastructure; broadening product definitions can raise barriers to entrants even higher;
- (iv) Threat of substitutes – SCPs can offer superior performance, customization, and customer value relative to traditional substitute products, reducing substitution threats and improving industry growth and profitability. However, in many industries these products create new types of substitution threats, such as wider product capabilities that subsume conventional products.
- (v) Bargaining power of suppliers – SCPs are shaking up traditional supplier relationships and redistributing bargaining power; SCPs ultimately can function with complete autonomy, with human operators merely monitoring performance, the fleet or the system, rather than individual units.

In product development SCPs require a fundamental rethinking of design: product development shifts from largely mechanical engineering to true interdisciplinary systems engineering. In manufacturing, these products create new production requirements and opportunities, going beyond the production of the physical object, primarily because a functioning of SCP requires a remote (cloud-based) system. This in turn affects organisational structure of companies. In a seminal article, *Jay W. Lorsch* and *Paul R. Lawrence* [17] had argued that every organisational structure must combine two basic elements: differentiation and integration. In this model, different tasks, such as sales and engineering, need to be “differentiated,” or organized into distinct units, which need to be coordinated and aligned. Now *Porter & Heppelmann* [26] affirm that the classical model a manufacturing business as one that is divided into functional units with substantial autonomy

(Research and Development – R&D, manufacturing, logistics, sales, marketing, after-sale service, finance, and IT) is no longer valid. With the emergence of SCPs, the need to coordinate across product design, cloud operation, service improvement, and customer engagement is continuous and never ends, even after the sale. In addition, as these authors argue, completely new and critical functions emerge – for instance, to manage an increased quantity and diversity of data, as well as the new open-ended customer relationships. At the broadest level, the rich data and real-time feedback from SCPs challenge the traditional centralized command-and-control model of management in favour of distributed but highly integrated choices and continuous improvement. The continued coexistence of the new and the old business models complicates organisational structures and certainly calls for additional managerial attention to redesigning the organisational structure and reshaping the traditional business offering.

Innovations as an indicator and an enabler of competitiveness in Serbia

Serbia strives to attain the stage described by Porter innovation-driven growth [22] in order to bridge the development gap, namely by fostering creative industries and market enablers, including a business-enabling environment, quality higher education and entrepreneurship culture (see [29], [31], [29] and [30]). The innovation activity in Serbia is here analysed by using the two relevant international databases, the Global Competitiveness Report (GCR) produced by the World Economic Forum – WEF [34], [35], [36] and the Global Innovation Index (GII) produced by Cornell University, INSEAD and WIPO [6], [7], [8]. While GCR studies the innovation infrastructure as an important factor for enhancing competitiveness, GII reviews the innovation inputs and outputs.

To set the wider regional context for innovation activity assessment, the principle competitiveness indicators are presented in Table 1. Countries that stand out as leaders in competitiveness in Central and East Europe (CEE) in 2015 are Estonia and Czech Republic, and among the South-eastern European countries (SEE) these are Romania and Bulgaria.

Table 1: Competitiveness and innovation activity in CEE (GCI and GII rankings)

Country	GDPpcPPP 2014	GCI – rank		GII – rank	
		2014	2015	2014	2015
CEE					
Estonia	45	29	30	24	23
Czech Republic	37	37	31	26	24
Slovenia	35	70	59	28	28
Latvia	53	42	44	34	33
Hungary	51	60	63	35	35
Slovakia	41	75	67	37	36
Lithuania	47	41	36	39	38
Poland	49	43	41	45	46
Average CEE	45	50	46	34	33
SEE					
Croatia	57	77	77	42	40
Bulgaria	69	54	54	44	39
Romania	74	63	53	55	54
Montenegro	81	67	70	59	41
FYR Macedonia	88	63	60	60	56
Serbia	83	94	94	67	63
Bosnia & Herzegovina	100	87	111	81	79
Albania	95	97	93	94	87
Average SEE	81	75	77	63	58

Note: calculated by authors.

Source: GCI – WEF [35], GII – [7], [8]

All CEE and SEE countries are ranked in 2014 and 2015 more highly in terms of innovation than in terms of GDPpc PPP. In addition, the positions of all countries (except Poland, Lithuania and Romania) are better in the GII than in the GCR in 2015. The presented data demonstrates that both the CEE and SEE countries, including Serbia,

have underused potential for commercialising innovation, which could enable improved competitiveness in the future, and hence a higher standard of living.

Table 2 features the two key GCI-evaluated determinants of competitiveness – macroeconomic and microeconomic (NBE – national business environment and SCOS – sophistication of company operations and strategy). Data show microeconomic determinant of competitiveness in Serbia to be at a lower level than its macroeconomic determinant. A key generator behind the deterioration of the microeconomic determinant of competitiveness is SCOS (Sophistication of company operations and strategy), which dropped from 106th in 2008 to 129th place in 2014 and 121st place in 2015. The second cause for deterioration of microeconomic determinant is the quality of NBE, which dropped from 85th to 102nd and then 96th place, respectively.

While the attained rankings are likely to improve in the next period, especially the business environment based on reforms such as introduction of electronic construction permitting in January 2016, they certainly evidence the importance of both professional management practices and a business-enabling environment for a country's competitiveness, and ultimately for fostering entrepreneurship and innovation activity.

Consequently, it is strategically important that Serbia bases its reindustrialisation process on strengthening the innovation activity, since the latter provides a basis for knowledge-intensive creative industries that are deemed essential for accelerated GDP growth and a shift to a higher stage of overall competitiveness and economic development.

Table 2: Macroeconomic and microeconomic determinants of competitiveness (GCI subrankings)

	Macroeconomic competitiveness			Microeconomic competitiveness			NBE			SCOS		
	2008	2014	2015	2008	2014	2015	2008	2014	2015	2008	2014	2015
Serbia	74	91	84	88	106	101	85	102	96	106	129	121
Bosnia & Herzegovina	84	58	85	106	90	107	103	90	106	121	93	114
Romania	78	89	75	70	81	75	68	79	74	79	87	80
Bulgaria	81	78	85	80	85	78	75	81	75	102	98	89
Macedonia, FYR	70	69	63	88	66	63	85	62	58	103	80	85
Montenegro	50	50	67	72	71	76	69	69	72	85	85	91
Albania	88	76	78	100	86	82	98	88	81	108	86	85
Croatia	66	74	75	67	79	78	68	77	77	62	83	86
SEE	74	75	77	84	82	83	81	80	80	96	93	94

Source: Authors' recalculations based on [22]. Rank versus 144 countries [34], [35], [36]

The here analysed Global Innovation Index [8] relies on two sub-indices – (i) the Innovation Input Sub-Index which consists of five input pillars capturing elements of the national economy that enable innovative activities (institutions, human capital and research, infrastructure, market sophistication, and business sophistication; and (ii) the Innovation Output Sub-Index, which is based on innovative activities within the economy (knowledge and technology outputs and creative outputs). The overall GII score is calculated as the simple average of the Input and Output Sub-Indices, and the Innovation Efficiency Ratio, which is the ratio of the Output Sub-Index over the Input Sub-Index, displaying the innovation output a given country obtains for its inputs. GII for 2014 includes 143 economies with 81 indicators, representing 92.9% of the world’s population and 98.3% of the world’s GDP (in current USD).

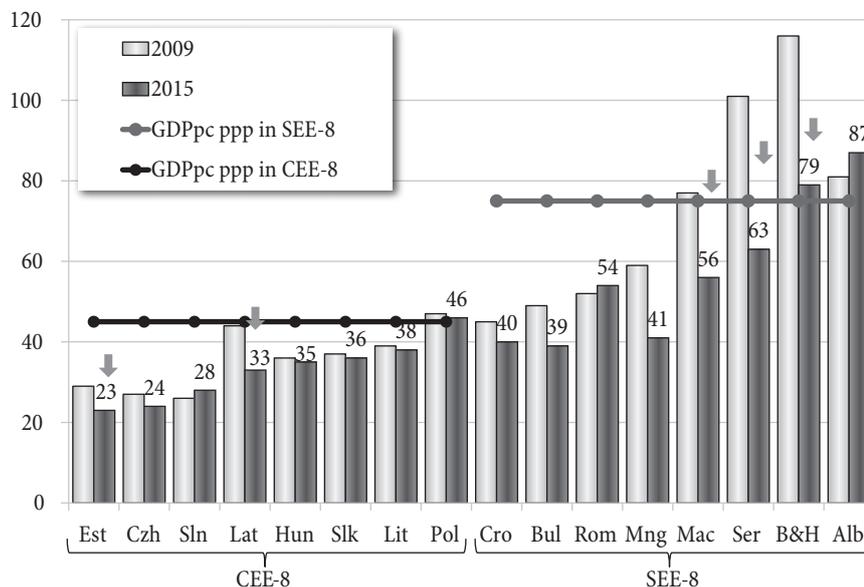
Figure 2 presents the country GII rankings [6], [8]. Three SEE countries, Serbia, Bosnia and Herzegovina and Macedonia, have all achieved significant progress but are still at the lower end of the region’s performance in terms of effective innovation output.

Figure 3 illuminates the state of the innovation infrastructure of Serbia based on aggregate data collected by the World Economic Forum. The larger the shaded area, the better the country is ranked. Strikingly, this indicates

that Serbia’s innovation infrastructure had been better developed in 2008 than in 2012 or 2015. Alarmingly, in two of the indicators, “Country capacity to retain talent”, and “Country capacity to attract talent” (previously integrated under one heading of “Brain drain”), Serbia is at the bottom of the world rankings (140th and 139th position out of 144 countries, respectively). For two additional rankings, “Quality of management schools” and “Quality of the educational system”, Serbia is positioned beyond 110th place. At the same time, Serbia scores considerably well for “Tertiary education enrolment rate”, “Quality of math and science education”, “Utility patents per million population” and “Quality of scientific research institutions”. Nonetheless, the indicator measuring the quality of scientific research institutions has deteriorated over time, implying that Serbia has been losing its competitive advantage due to either decreasing quality, and/or other countries undertaking a more substantial effort to enhance the quality of research.

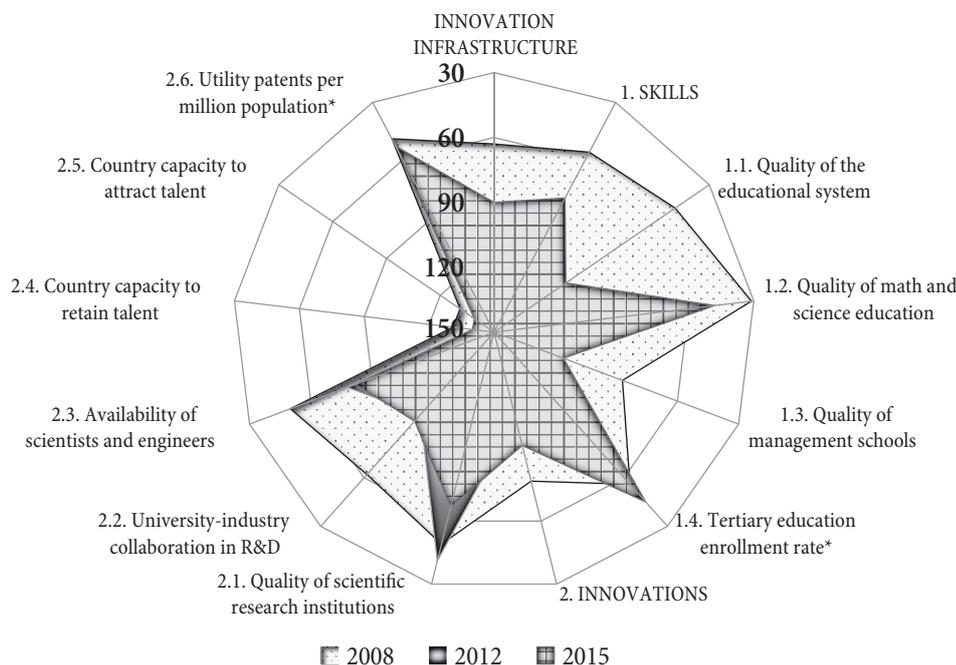
Figure 4 is showing the effectiveness of GII outputs based on the available inputs in a country. The results in 2015 are weaker compared to 2012, especially when assessing the “Knowledge & technology output” and the “Creative outputs”. Outputs relating to “Innovation institutions”, “Human capital and research” and “Innovation infrastructure” are showing improvement over time. In contrast, meager results have been achieved in outputs relating

Figure 2: Global innovation index rankings



Source: Cornell University, INSEAD and WIPO, The Global Innovation Index 2009/2010 and 2015.

Figure 3: Innovation infrastructure in Serbia



Source: WEF [34], [35], [36]

to “Business sophistication” and “Market sophistication” indicating weak linkages between the education system and research institutions on one hand, and the business sector, on the other hand.

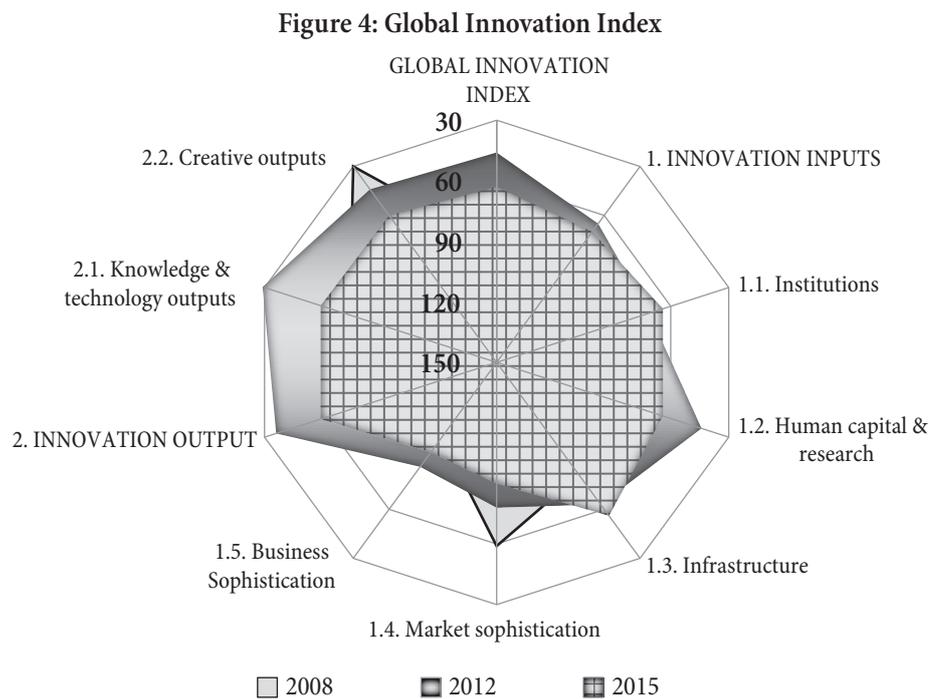
According to previously presented research by *Savić, Pitić & Trbović* [29], [31] based on Porter’s competitiveness model and affirmed by assessment of 2015 GCI, Serbia is currently at the investment-driven stage, with further development conditioned upon new investments in increased productivity of goods and services. At the same time, although Serbia has reached this second of three stages of development as described by *Porter* and evaluated by the World Economic Forum, it has done so without a sufficiently developed infrastructure (roads, railways, ports and the like) or administrative infrastructure (weak rule of law, public administration, prevalence of corruption, etc.), and with poor basic human capital.

As a consequence, Serbia has a relatively low competitiveness as 94th of 144 countries in 2014 and 2015. On the other hand, Serbia has considerable results in several of the competitiveness elements, including elementary education, primary health care and part of telecommunications infrastructure. Therefore, Serbia should commit to resolutely completing the outstanding tasks ascribed to first stages of development, including

development of physical and institutional infrastructure, and at the same time focus on improving the quality of human capital to advance further on the development path. Serbia particularly needs to reinforce the elements of competitiveness linked to innovation infrastructure (skills and innovations), which will enable it to ultimately shift to the most advanced innovation-driven stage of competitiveness. More specifically, Serbia should enhance the quality of scientific research institutions, strengthening the university-industry R&D collaboration (evidenced in increased number of patents, technology-based companies and other indicators of commercialising innovation) and the country’s overall capacity to retain and to attract talent. Both the business sector and the government play a role in providing impetus to these processes.

Fine-tuning of the European Union’s innovation policy

The European Union, recognising the crucial role of innovation in economic development and responding to what it calls ‘innovation emergency’ of lower R&D spending compared to other developing countries, namely USA and Japan, and researchers moving to countries where conditions are more favourable, has formulated



Source: [6], [7], [8]

the Innovation union policy to render research more integrated and efficient. The EU policy-makers estimate that reaching the target of investing 3% of EU GDP in R&D by 2020 could create 3.7 million jobs and increase annual GDP by EUR 795 billion by 2025.¹

The EU plays special emphasis on the Information Communication Technologies (ICT), since this sector represents 4.8% of the European economy, and generates 25% of total business expenditure in Research and Development (R&D), with investments in ICT accounting for 50% of all European productivity growth. As a result, the EU investments in ICT are due to increase by about 25% under Horizon 2020 compared to FP7, which was the previous framework EU programme for scientific projects.² In reviewing the overall EU and member countries research and innovation performance, the most recent European Commission report [11] reveals that there is still insufficient funding, slow institutional reform and untapped potential in linking business to education and stimulating innovations. These challenges are only magnified in Serbia where lower level of economic development further limits opportunities and enhances resistance to reform.

1 Available at <http://ec.europa.eu/research/innovation-union>

2 Available at <https://ec.europa.eu/programmes/horizon2020>

To strengthen the EU policy in innovation, the EU Research Commissioner *Carlos Moedas* has recently announced plans to establish the European Innovation Council in addition to the existing European Research Committee and counteract the trend of technologies developed in Europe commercialized elsewhere [16].

In Serbia, the Draft Strategy for Science and Technology Development 2016-2020: Research for Innovation [10] has a strong focus on innovation and supporting science based on excellence and relevance as the two key criteria, which would render the sector more effective in the future if the financing and overall institutional reform is gradually implemented, as envisaged by the document. Based on positive results since inception in 2011, the Republic of Serbia Innovation Fund could be an important vehicle in strengthening links between the education and research sectors, one hand, and the business sector, on the other hand, as proposed by the review of Serbia's international competitiveness presented above. Business incubators, university technology transfer offices and curricula reform also play an important role as building blocks of innovation that need to rest on advancements in general physical and institutional infrastructure and rule of law that all contribute to a functioning, stimulating business environment.

Development of smart connected products in Serbia

As a country that has not yet reached the innovation-driven stage of development, Serbia is seldom a country of origin for smart connected products. Nonetheless, there are some positive signals indicating future potential. Most specifically, Serbia's ICT sector exports, while still relatively small in volume on a global scale, are exhibiting constant growth, especially when it comes to export of computer and information services i.e. software development, a key element of SCPs. In 2013, Serbian ICT industry ranked 40th globally in terms of value of exported software, while the overall industry was ranked as 79th [32, p. 9].

Figure 5 presents export growth, year-on-year from 2007 to 2014, with the rate of growth dropping with the emergence of the Global financial crisis in 2008 but nonetheless not breaking the growth pattern.

Since the change of regime in 2000 and renewed economic activity, Serbia has developed specific IT skills in embedded systems development and application development, both in the entertainment industry and in tailor-made applications development.

One of the principle limitations to ICT development relates to human resources. There has been a significant brain drain of specialists that started in 1990s and is continuing today with best students studying abroad and usually staying there to work after their studies. Education capacities are deemed to be relatively good at a global level, particularly at technical faculties at the University of Belgrade and Novi Sad and the overall English proficiency in the country, but there are an insufficient

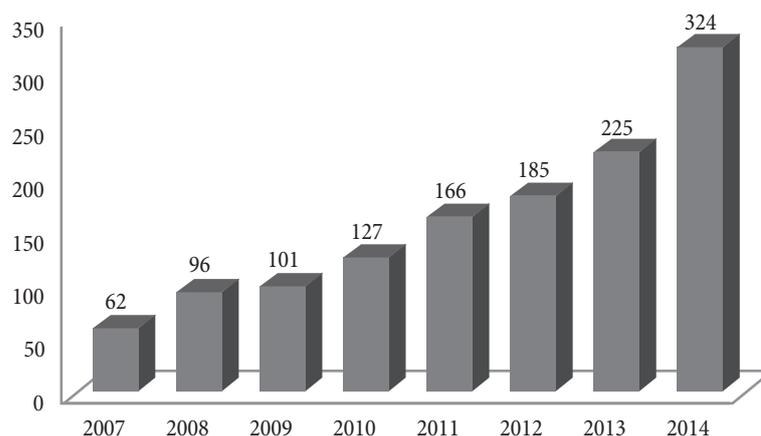
number of trained programmers, especially specialists, to draw further foreign investment in the sector. As a result, the ICT sector is growing based on outsourcing of more general programming and shared business services, at a rate that is conditioned upon the human capital availability.

The capacity for research and development in Serbia is also quite limited. In addition to university research laboratories, the most important ICT research centre is the Institute Mihajlo Pupin, which has certain capacities in the embedded design industries. Otherwise R&D occurs at the company level, and all of these research efforts are generally at a small scale.

The telecommunications market is the most developed segment of the ICT in Serbia. This market can be defined as mature and dominated by large companies (three mobile operators, and two major cable operators), with the average annual growth rate of the Serbian telecommunications segment revenues in the period 2005-2011 at around 9.5%. [33, updated by authors, p. 2]. This telecommunications market has been further strengthened by the KKR investment fund acquisition of a regional cable and Internet provider (SBB/Telemach) in partnership with the European Bank for Reconstruction and Development (EBRD) as a minority shareholder in 2013, and the NCR opening of a global centre in Belgrade in 2012.

In the IT area, there are several major industry players, with Microsoft's fifth development centre worldwide opened back in 2005 in Serbia, Asseco, one of the IT leaders in CEE acquiring a Serbian banking software development company in 2008 and currently employing over 500 engineers. Serbian-owned Comtrade as one of the largest

Figure 5: Serbia's IT service exports



Source: Serbian Chamber of Commerce

IT companies in CEE with over 1,000 engineers on 16 locations globally, local company DMS producing the top global software solution for energy distribution entering a joint venture with Telvent, now Schneider Electric and employing over 1000 experts, Bitgear and HTec named Deloitte's second and third fastest growing technology company in Central and Eastern Europe, respectively, and Nordeus as a leading and award-winning European game developer (officially the best European gaming start-up of 2011), followed by Elpix Entertainment, Cofa games, GTECH, and other software development companies that are gaining international traction [32]. Other ICT multinationals are also present on Serbia's IT market (Adobe, Oracle, Google, Hewlett Packard, SAP, IBM, Siemens, Cisco, Ericsson, etc.) but mainly as wholesalers, although some are outsourcing certain services to Serbian IT companies.

Several Serbian companies are successful in producing smart connected products (products under the Internet of Things umbrella), and three examples will be presented here. For instance, Schneider Electric DMS NS Ltd engages in research, development and engineering in the field of the electrical power engineering management software. Their main product, ADMS Software encompasses a variety of analytical functions for calculation and optimization of the electrical distribution utilities operation and provides the tools necessary for efficient monitoring, managing and design of distribution systems. This software tool enables utilities to obtain high-quality information about their power distribution network, efficiently design and develop distribution facilities, optimize resources and reduce operation costs, raise the utility profitability and improve both availability and quality of electricity for customers. The product developed by Schneider Electric DMS NS Ltd. has transformed the energy management system and it is today deployed in 156 Control Centers in 72 Utilities worldwide, supplying 90.4 million customers.³

The second example is Strawberry Energy, a small innovative company that produces smart urban devices, namely public solar-power based charging stations for portable devices, providing people with energy, connectivity and local information in public spaces. While this company is

just starting to gain revenue, including orders from United Kingdom and other destinations, its potential has already been recognized and they pride themselves with many awards, including a prize by the Institute for Sustainability in partnership with the Mayor of London's Office, and supported by EIT Digital, 2015, First place in the Public Consumption Reduction category at the European Union's Sustainable Energy Week 2011 in Brussels, and Winner of the Verge Accelerate competition, in the organization of GreenBiz Group in San Francisco, 2014.⁴

The third example is one of Bitgear, another awarded high technology company that specialises in modern electronics, digital communications and signal processing technologies that are based on motion sensors and web software. In addition to providing solutions to other businesses that are either components or integrally created smart connected products, Bitgear develops its own smart connected products and platforms. This is an interesting example of enhancing the services business model, with the company aiming to achieve non-linear growth as an innovation driven enterprise investing at least 20% of resources in own R&D. One of the systems that Bitgear licenses is based on "wearable" technology that enables an interactive relationship with the elderly, children and pets, enhancing security and health habits. Another system is the "car sharing" hardware and software platform, which enables users to book a car for a short period of time and unlock it using their mobile phone. An interesting example of a connected product developed by Bitgear for other businesses is a wearable device for monitoring domestic livestock animals, which is mounted on the tail of an animal and, on the basis of tail movement, determines the stage at which calving will occur. The device sends an SMS with a short description of any significant events, enabling the farmer to react in a timely manner in case of any problems, without having to constantly supervise and visit animals. This is especially effective when animals are in a remote location (Interview with Dejan Dramicanin, Bitgear CEO, held in February 2016).

In conclusion, whilst the bulk of the IT production and exports volume in Serbia can be ascribed to outsourced,

³ For more, see Official Company Internet Presentation, available at <http://www.schneider-electric-dms.com/>

⁴ For more, see Official Company Internet Presentation, available at <http://senergy.rs/>

general software programming, examples of several companies presented here is evidence of future potential for smart connected products (or Internet of Things) development. For more companies to specialise and successfully compete at the global level, additional, principally foreign investment in the sector is required. The key limitation here, in addition to the deficiencies in the business climate presented in the more comprehensive evaluation of Serbia's competitiveness above, is the availability of quality human resources, which calls for increased public funding of education in the relevant ICT skills, shifting resources away from funding education for competences where the market is demonstrating high unemployment levels. Furthermore, we wish to reiterate the recommendations related to reform of research and innovation infrastructure and gearing publicly available funding for innovation principally via institutions like the Innovation Fund, which is functioning based on best international practices. Previous experience with subsidising companies based on less transparent and less competitive criteria has shown that such policies inevitably result in market distortion and unfair competition, and should thus be replaced with smart innovation policies.

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