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Responsible Innovation & Entrepreneurship

30th September – 1st October 2019
Thessaloniki, Greece

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SHORT/FULL PAPERS

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CAN WE STILL SPEAK ABOUT THE INNOVATION PROCESS *PER SE*? CHALLENGES FOR MANAGERS

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Abstract: In this paper we are analyzing the influence of open innovation on the structure and organization of the contemporary innovation process. The main hypothesis assumes that the contemporary innovation more and more often comes as a result of a quite loose set of dispersed processes and not of a put-in-order, several-phase innovation process. The paper starts with a literature survey followed by selected empirical cases. On this basis, the multi-process model of technological innovation is presented. Afterwards, we identify implications for practice, especially the main challenges to be faced by managers of innovation processes in industrial firms.

Keywords: innovation; innovation process; innovation management; open innovation

1. Introduction

There is a rich literature on the economics and management of innovation processes that documents innovation dynamics in the 20th century. In the traditional understanding of innovation - as it was shaped by the views of numerous scholars and practitioners over the past decades -the innovation process consists of several phases or components and relations between them; it has a number of characteristic features [interactivity, complexity, etc.] and is driven by internal mechanisms; it usually receives the organizational form of an innovation project. However, in the context of multiple drivers that change our world at an unprecedented pace - including the advanced globalization of markets, capitals and technologies, the increasing international mobility of human capital and the changing nature of social and organizational relationships under the influence of new technologies - is this traditional meaning of the innovation process still valid? In other words, can we still envision the innovation process in the 21stcentury along the lines defined in the 20thcentury? The inspiration to formulate such questions has been [10] book on *Open innovation.* But firstly let's move back in time.

From the historic perspective, in the market economy, ideas for innovations have usually appeared in firms, even in situations when idea generation has relied on results from university research, contract R&D or joint research projects. Contract research run on order fits within the innovation process initiated in the enterprise. [10] calls such innovation 'internal,' and considers it as part of a 'closed' innovation paradigm, whereby "you must 'make' your ideas and monetize them through your own products" [*ibidem,* p. 155].

In contrast, the 'open innovation' paradigm, which has become widely popular nowadays, assumes that "there is a bountiful supply of potentially useful ideas outside the firm, and that the firm should be an active buyer and seller of intellectual property" [*ibidem,* p. 155]. Open innovation provides opportunities for deriving benefits from using intellectual property outside the firm [outbound streams], as well as from utilizing external knowledge [inbound streams] – see [12]. To illustrate: from the enterprise's point of view, open source software may be an example of the outbound stream while crowd-sourcing – of the inbound stream. In practice, both types of the open innovation process – 'internal' and 'external' - are mutually connected.[1] Frankly speaking, it can be credited to Chesbrough that he has skillfully named the phenomenon which has been taking place for quite long.

Other features of an 'open innovation' process can be identified from the work of other scholars. For example, [43,56] associates open innovation with the fourth generation of R&D management methods that assume, among other things, the division of research tasks among partners located sometimes in various countries. In [52] opinion, according to the systems theory, an R&D project may be called open, i.e.,"it is the system getting in interactions with the environment" [p. 30]. According to [47], the driving force of technological progress in the modern economy is no longer concentrated around a researcher/research team/research organization, but it largely depends on the existence of an innovation ecosystem, which includes innovating entrepreneurs and a multitude of business and innovation support structures.

This paper may be treated as a voice in the debate on the future of innovation studies [IS] that was initiated by [59]. The author formulated a list of twenty advances in IS over the previous 50 years, among them [*ibidem,* Table 1]: from the linear model to an inter-active 'chain-link' model; from 'Mode 1' to 'Mode 2" and from closed to open innovation.

[1] The considerations in this paper refer to 'inbound innovation.'

On the basis of the above list, [60] proposes also twenty challenges – some of them being dilemmas – for innovation studies, including challenge No14: *Balancing the intrinsic tensions between closed and open innovation [ibidem*, table 6]. He shows some reservation towards Chesbrough's concept of the open innovation model by asking:

> *'[…] if large numbers of organizations simultaneously adopt an aggressively open approach towards innovation, will there be adequate R&D conducted 'elsewhere' upon which they can all draw?' [60].*

The unit of analysis in this paper is the innovation process, not the firm or another economic entity. This assumption results from the fact that the contemporary process of innovation goes far beyond the enterprise.

In light of the above, this paper aims to answer the question: *Can we still speak about the innovation process as such?* i.e., in the traditional understanding and organization as above. An additional aim is to identify new challenges faced by the managers of technological innovation in industrial firms. The answer to this question is important both for theory and for practice. To this end, the following research methods have been used: a literature survey, case-studies and a descriptive model. Hence, the next parts of this paper are devoted to the literature review [section 2], cases from practice [section 3], the multi-process model of innovation [section 4], challenges to be faced by managers [section 5], and conclusions.

2. The innovation process as the unit of analysis: A literature review

2.1. Various approaches to the innovation process

Let's start with the concept of a process. A process is a suitably put-in-order set of actions/ operations; and referring to production, a production process is a suitably put-in-order set of production operations [23]. [26] defines a process as 'a sequence of the actions transforming an idea and an effort of workers into the effect determined by a client waiting for it' [p. 23].

In literature practically every author gives a bit different version of the innovation process concept defined for their specific research needs [e.g., [3]; [41]; [70]; [72]. All the authors would surely agree with a very general statement that the innovation process usually is understood as *a put-in-order sequence/set of the actions/operations that lead*– shortly speaking – *to innovation.* According to *Oslo Manual* [69], innovation is a continuous, dynamic process. The manual, however, does not give a definition of the innovation process as such.

So, a traditional understanding of the innovation process assumes its continuity, operations put in order, sequence of events, reason-effect relations among individual actions and a strong structuring of the process. However, let's now imagine that an international or domestic consortium has fulfilled a big research project. Then it turned out that one of the research results could be practically implemented in an economic entity not being a part of the consortium. So, we can ask: Was it the innovation process/project, understood as above, aiming at the implementation of its results? Moreover, a practical implementation of a new product or a new production technology confirms that the innovation process took place [69]. So, we know *post factum* that the process deserved the name 'innovative'.

[28] recommends a systems approach to the innovation process. He designs a new dynamic innovation system concept that is constituted by five main subsystems: [1] Knowledge Creation; [2] New Product Development; [3] Product Success in the marketplace; [4] the Internal Factors that influence a firm's core innovation process and [5] the National Innovation Environment.[2] The core innovation process, not defined by the author, consists of the first three subsystems. The five subsystems operate in parallel and influence each other. The author has named this abstract concept the Creative Factory because its purpose is to provide a tool—the 'factory'—that will improve innovation activity—the 'creativity'—of a firm [p. 1225]. So, in this model, these are [five] factors influencing the creative factory concept.

As seen, new product development [NPD] here is one of the five subsystems. In literature, a few models of the NPD cycle are known; e.g., a very popular stage-gate model [14] and other models [88]. Both concepts, i.e. the innovation process and the NPD cycle, overlap. The differences between them are very fine: NPD refers to a product innovation only, while there exist process innovations too; the innovation process typically embraces R&D while NPD - not necessarily; NPD is usually considered from the firm's point of view where the product development is often determined by the existing technology used in the enterprise, and treated as a new business project rather than a research project as in the case of the innovation process that, as mentioned, goes far beyond the firm.

Coming back to [28]: he presents a very complex and sophisticated influence diagram for the innovation process. The diagram is a high-level model that can be used by managers to provide a general understanding of

[2] Galanakis surely thinks here about a National Innovation System (NIS).

the relations between the different factors that form an innovation system [or rather process – AHJ]. According to [52], one of crucial elements of the systems approach is the analysis of the project's environment and of its influence on a given project [p. 30].

Other authors recommend a systems perspective in analysis of innovation processes, too [e.g., 9,11]. They speak about the innovation production process [IPP], in other words – product innovation process. Apart from the terminology, an important thing here is that the authors put stress on functionally distinct innovation activities and interdependent interactions between these distinct activities within the process of innovation.

A big emphasis on factors influencing innovation is put by [8] in his systemic model of innovation which includes factors [managerial, economic, cultural, psychosocial and individual] and inter-relations between them. The author, however, seems to be an advocate of the phase-after-phase approach to the innovation process.

In literature, one can find more and more supporters of a process approach to innovation activities, which creates a dynamic picture of their participants' actions; see e.g., [5], [22], [42], 44], [71], [80]. [5] recommends a transition from the structural thinking to the process one. He calls the latter a process thinking paradigm.

According to [73], a process is a value chain where a value creation takes place at each stage of a given process. It is assumed that each consecutive action increases the cumulative value of the previous actions. A total production cost should be smaller than the arising benefit for the client. On the basis of this, [15] proposed a definition where a process is a chain of logically connected operations, consisting of such transformation of the organization's resources that – from the view-point of the client – a value of the result at exit is higher than a value at entry.

As seen, the process orientation consists in a value creation for the client both internal and external/final [62,63]. In the case of technological innovation, [34] speak about the innovation value chain. So, the process approach to innovation assumes a flow of value for the client in particular phases of the innovation process. There are no contradictions between this approach and the previous one.

Innovation is a team game – in a double sense [87]. Firstly, innovation always requires the collaboration of many workers in the firm. Secondly, innovation requires the firm's cooperation with numerous entities in the environment, i.e., other enterprises, research organizations, banks, etc. One of the results or rather conditions for such game is the necessity to resign from the mindset of an individual competitor.

According to new Accenture research conducted among1,000 large companies and 1,000 entrepreneurs, 82 percent of large companies say they can learn from entrepreneurs about how to become a digital business and 50 percent believe they need to work with entrepreneurs to be sufficiently innovative [35]. The real message is that too seldom do large companies collaborate in a spirit of joint innovation [*ibidem*, p. 24]. In turn, [87], using panel data of 325 firms over five years, found that externally-sourced knowledge takes less time to absorb and exploit than internally-generated knowledge, but that internal knowledge creates higher returns over the longer time.

2.2. Types of the innovation process

As mentioned in Introduction, the innovation process usually occurs in an organiza-tional form of innovation project. However, there is no single type of the project, so there is no single kind of the process. In practice, different innovation projects result in different innovation processes [78]. According to [80], innovation projects may assume specific process configurations to address specific situations and contingencies.

Following [80] considerations, [78] tried to find such configurations in order to answer the question: Which innovation processes best fit in various types of projects? During their empirical studies of 132 innovative projects in 72 Brazilian companies, the authors identified eight types of the innovation process different in terms of structure and content. These are [78]: [1] traditional process: from idea to launch, [2] anticipating sales: the tailor-made approach [open order], [3] anticipating sales form a given client specification [closed order], [4] process started by a call/bid, [5] a process with parallel activities, and three varieties of process with a stoppage: [6] waiting for the market, [7] waiting for the advance of technology and [8] waiting for the market and for the advance of technology. As seen, contemporary innovation processes occurring in firms can be designed in various ways.

[51] also tried to classify innovation processes and types of innovation. For them, innovation is the creation of a viable new offering. This definition seems to be a bit too narrow because a new, innovative manufacturing technology, being a process innovation implemented in a given enterprise, may not be a subject of offer/sales.

These authors identify a set of eight – as they call – types of innovation processes that include [51]:

- two types of innovation focused on more customer-facing elements of an enterprise and its business system: [1] innovation of the customer experience and [2] innovation of the product idea and concept,

- three types of innovation focused on an enterprise's core product or service, or its collection: [3] innovation of the product functionality, [4] innovation of the design and production process and [5] innovation of the corporate culture, and
- three types of innovation focused on innermost workings of an enterprise and its business system: [6] innovation of the attitude towards venturing, [7] innovation of the network and [8] innovation of the organizational model and structures.

These *de facto* are types of innovation. However, one may find a set of 'ten types of innovation', such as: the way in which you make money; networks with other to create value; alignment of your talent and assets; signature of superior methods for doing your work; distinguishing features and functionality; complementary products and services; support and enhancements that surround your offerings; how your offerings are delivered to customers and users; representations of your offerings and business; and distinctive interactions you foster [Keeley *et al*, 2013]. In our opinion, these can rather be understood as features of contemporary innovation processes or can be seen as a mixture of types of innovation and innovation processes.

2.3. Components of the innovation process

As seen, various authors not only classify innovations and innovation processes in different ways. Also, they differently classify and name individual phases/stages of the innovation process. However, they converge in thinking that at least three phases should take place: R&D, production implementation, and commercialization. As known, a contemporary innovation does not follow a linear path that begins with a new idea and then moves through research, development, design, engineering and production, resulting into the introduction of new products or\and processes.

Moreover, we are witnessing a considerable number of innovations that do not involve R&D [2]. Sometimes it is enough to conduct development/experimental work with the participation of company engineers [designers and technologists], as in the design thinking model. In the latter case, product innovations usually came into being in Apple Corporation [39] where it was not scientists, but engineers who played a crucial role in creation of novelties by using accumulated scientific S&T knowledge.

Three of the above-mentioned main components of the innovation process essentially differ between each other as regards the nature of actions, the specialization of executors, the sphere of activities and executing entities [see the Table A the end].

Ad 1] In Central and Eastern European countries, for example, the vast majority of new scientific and technological solutions/achievements emerge outside the enterprises, most often – in higher education institutions, institutes of the Academy of Sciences and other research organizations [46],

Ad 2] Indeed, a production firm is usually the place where technological change appears and afterwards is being launched into the marketplace [product innovation] or installed in the firm [process innovation].

Ad 3] In order to commercialize a new product, the enterprise management usually has two options: [1] to create a new unit within the company and entrust this unit with the task of commercializing or [2] to establish a separate firm for this purpose [13]. So, according to [52], a key problem here is to decide on the legal form of the unit responsible for the commercialization of the results of a research project.

In order to introduce a novelty into a foreign market, producers-innovators sometimes use services offered by firms specializing in the commercialization of new products. These are the enterprises that operate as trade representatives or distributors in a given market, especially when the producer's brand is new there. Sometimes such practices also take place in a domestic market. For instance, such role was played by Lotus Corporation when launching one of IBM's new products into the American market [53].

An interesting difference between research on the one hand, and innovation understood here as the first commercial use of a new [or improved] product or/and a new process [25] on the other hand, was pointed out by P. Nightingale:

> *'Innovation starts with a desired end result and attempts to find unknown starting conditions that will achieve it. Scientific knowledge, by contrast, goes in the opposite direction: from known starting conditions to unknown end results' [68].*

This difference may prove that loose connections sometimes exist between particular components of the innovation process.

2.4. Recent innovation pathways

In the recent literature, many authors use the concept of pathway in the context of technological innovation. For instance, [29] present their typology of socio-technical transition pathways based on the multi-level perspective [75]. [29] mean transition as a system change from one socio-technical regime – an extended version of [66] technological regime – to another. Such transitions take place thanks to technological niches where radical

novelties emerge; therefore are called niche-innovations. Socio-technical regimes and technological niches have a character of organizational fields [*ibidem*, p. 400].

The authors distinguish four transition pathways that differ in combination of timing and nature of multi-level interactions: [1] transformation, [2] reconfiguration, [3] technological substitution, and [4] de-alignment and re-alignment [29]. Within each pathway, a niche-innovation is a kind of germ.

Three years later, an interesting concept was published by [75] who introduce the notion of *distributed innovation*. They start with the observation concerning innovation pathways by writing that:

> *'one striking feature is the recent shift from the idea of centralized organization of innovation to explicit recognition of the importance of distributed and more diverse innovation, even if that means some loss of control for central actors. An example would be the present interest, within a number of big companies, in open innovation'[p. 20].*

Therefore, they call for more attention to distributed innovation in contrast to centralized innovation, where

> *'innovation was produced and/or orchestrated by a central [focal] agent, […] distributed innovation is observed in situations where heterogeneous actors who hold complementary pieces of knowledge interact and form networks of creative communities; they cooperate in quite informal ways and co-construct the technology for a joint use' [ibidem, pp. 22].*

So, in our opinion, open innovation and distributed innovation may be treated as equivalents.

The authors speak about a regime of innovation[3] but in a different sense than [29]. [75] have identified two specific ways to organize and promote [and to govern] innovation in contemporary society, which they have labeled as [1] the regime of economics of techno-scientific promises and [2] the regime of collective experimentation.

They conclude that innovation models are not unique and are constantly reinvented by actors. There is no one single best way/pathway to innovate. But the authors add that a vibrant European knowledge society can be built if there is sufficient attention to collective experimentation [75].

It is also worth adding here [83] view on innovation pathways:

> *'innovation of all kinds in any given area is not a one-track race to the future. Instead, it is about social choices across a variety of continually branching alternative pathways for change. In this sense, innovation is more like an evolutionary process, than a race. It is as much about exploring a space of different possibilities, as optimizing any one [and] there unfold many radically contrasting alternative pathways for innovation' [ibidem, p. 52].*

Sterling adds that a robust knowledge base and rigorous analysis are both necessary to expand on alternative innovation pathways within or across different domains. Critical appraisal of the driving forces behind alternative innovation pathways [not just the claimed aims] can be undertaken with confidence at an early stage of the innovation process, despite the uncertainties [*ibidem*, p. 54].

In concluding, he underlines once more that innovation is not so much about a race to optimize a single pathway, as a collaborative process for exploring diverse alternatives [83]. Of course, the chosen innovation process must be completed afterwards.

In summarizing the hitherto considerations [sections 1 and 2]: traditionally, innovation is usually seen as a process consisting of several phases/stages from the view-point of the firm. However, there exist substantial differences between the phases, various process configurations, various types of the innovation activity and various innovation pathways. Moreover, the innovation process nowadays becomes open, distributed and more diverse than in the 20th century.

So, the question -*Does the innovation process in a traditional meaning still exist?* - seems justified. So, a new conceptualization of this process seems to be needed. For this purpose, the theoretical literature survey is not sufficient. We must have a look at practice.

3. Cases from practice

We have been looking for practical examples to check whether the open innovation mechanism rips the innovation process open. Four cases have been identified and analyzed.

3.1. *Merck*[4]

[3] A regime, here a regime of innovation, contains a model, or paradigm, that is a notion of how things must be done (Rip *et al*, 2010, p. 21).
[4] Based on [10] (2003).

Merck is perhaps the leading pharmaceutical firm in the world in terms of doing its own research. Merck has charged its internal scientists with a new task: to create a virtual laboratory in their research area. This means that Merck scientists don't just create excellent science in their own lab; they rather identify and build connections to excellent science in other labs, wherever these labs may be. In the words of Merck's head of R&D - 'Every senior scientist here running a project should think of herself or himself as being in charge of all the research in that field. Not just the 30 people working in our lab but the 3,000 people, say, in the world working in that field'-. This is a good example of the way to join an external, international base of scientific and technological knowledge. Nevertheless, Merck was already well networked into the international research community.

3.2. *Procter and Gamble*[5]

At the beginning of the 21st century, Procter and Gamble [P&G] Corporation adopted a new strategy called *Connect and Develop*. The strategy is directed towards seeking and developing innovation emerging in various places of the world. Within this strategy, P&G cooperates with individuals, industrial enterprises, laboratories, research institutes, universities, financial institutions, clients and suppliers. They belong to the P&G Innovation Network. In this way, the Corporation does not rely only on the innovativeness of own 7,500 R&D workers, but can use ideas of 1.5 million people from outside P&G who joined the Internet Platform *Connect and Develop*. This has allowed the firm to significantly speed up innovation processes and gain numerous quite new ideas for innovation.

3.3. *Nokia*[6]

As known, Nokia has recently sold its Cell-phone Division to Microsoft for USD 5.4 bn. Microsoft has bought it together with the whole knowledge hidden in Nokia's patents and know-how. The new President of Nokia now says: -'We try first of all to develop our own ideas in our labs although we don't hesitate to buy the firms which dispose of the solutions more advanced than those we have. Recently we have bought Mesaplexx – a small Australian enterprise highly advanced in filter technologies needed in basal stations. Mesaplexx's devices – being the result of many-year work – are a few times smaller than ours. This new technology, bought together with the firm, will allow us to design smaller and more effective energetic basal stations. […] We have also bought two enterprises dealing with data analyses. Their technologies will be useful in HERE – our pillar considering maps and navigation. Sometimes we opt for a strategic partnership: in this way, we cooperate with a firm Juniper working together on the solutions regarding services in the cloud'-.

3.4. *IBM*[7]

In the middle of the first decade of the 21st century, IBM Corporation adopted a strategy of development of the innovation ecosystem based on the open innovation model. According to S. Palmisano, IBM President: 'Innovations are not created through increasing an own R&D budget but via creation of the environment in which they emerge and develop'. As an example we can mention JAVA – a language of programming that has been born in the result of a broad R&D cooperation between IBM and a few international enterprises dealing with the programming.

It is worth adding here that IBM has nine main R&D centers of which only four are in the U.S.; the other are located in Sao Paulo [Brazil], Hursley [England], Bangalore [India], Beijing [China] and Yamato [Japan]. The confirmation of the fact that IBM is oriented towards scientific and technological cooperation with the foreign environment can be, for example, a number of enterprises dependent on IBM which operate outside the U.S. There were 75 such firms in 2009 [perhaps not all of them conducted research and development].

Moreover, the Corporation took over 134 enterprises in the years 1998-2009 following such criteria as: [1] patents and trademarks, [2] *R&D projects in progress***,** and [3] complete technologies. In other words, it was the orientation towards capturing an external scientific and technological knowledge. As regards the second criterion, we may assume that those processes/projects were/are continued in IBM.

3.5. Summary

The analyzed cases deliver proofs that, in certain situations, open innovation causes that a contemporary innovation process does not constitute a pithy whole any more. The described enterprises have applied various methods or forms of their participation in the open inbound-innovation mechanism. Each of the analyzed firms decided to join the innovation processes *in progress* somewhere in the world and to use the knowledge that circulates in global networks. These enterprises follow the principle: 'We must gain external, someone else's knowledge as much as possible' especially because there is 'a bountiful knowledge landscape' [10]. Afterwards, the firms incorporate the obtained knowledge into their innovation processes/projects 'at home.' This means that the transfer of scientific-technological knowledge has taken place, sometimes through the purchase of another enterprise.

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[5] Based on Huston and Sakkab (2006).

[6] Fragments of the interview with R. Suri, President of Nokia ('Polityka' weekly, No 30/2014).

[7] Based on T. Sierotowicz's PhD elaborate, Jagiellonian University, Krakow, 2011. Also [10] (2003) treats IBM as a paragon to be followed by other corporations.

The considerations in this section seem to prove that nowadays, the innovation process *de facto* is *a combination of dispersed processes*, partly independent, very diverse and complicated. This undoubtedly is a new organizational field being a result of reconfiguration of the innovation process but it can't be treated as a new socio-technical regime. According to [7], the process of innovation now is a set of different, parallel, competitive and contradictory processes often taking place at the same time, which creates a bit chaotic composition. In our view, the concept of distributed innovation refers to dispersed processes.

So, a contemporary technological innovation is the result not of one but of several processes. However, here we don't mean the depiction which assumes that innovation is the result of a complex set of processes inside the organization [18; 28; 78].

As described in the previous studies [47], we are witnessing the strengthening of the following features of contemporary innovation activities: [1] *a bigger openness of innovation*, the basis of which is [2] *creation and flows of knowledge* which are not possible without [3] *abroad, varied cooperation***,** sometimes loose or informal, which may turn into [4] *creative partnership***,** more and more often strategic, which takes place [5] *in the context of ecosystem* that is very dynamic.

4. The multi-process model of innovation

On the basis of the observation that a contemporary technological innovation is – more and more often – a combination of processes [not phases], the multi-process model of innovation has been elaborated [47]. Its assumptions are as follows:

1. Innovation 'stands on two pillars': while one pillar still lies in the R&D sphere, another one already lies in the production sphere, and between the two there is a transfer or flow of scientific and technological knowledge [45].
2. Sometimes there is no continuity from R&D to production implementation, for example, when the results of a research project – undertaken by a research organization on its own initiative – go 'on the shelf' after being finished. Moreover, not only new [the newest] knowledge is being used in innovation activities but accumulated knowledge is often used too, as in the chain-linked model [54].
3. Particular partial processes can be and are held at different times and at various places of a national or even of the world economy as a result of 'the distributed nature of knowledge production' [75] or of 'the dispersed process of knowledge production' [91].
4. We witness the internationalization or rather globalization of innovation processes [by some people called techno-globalism[8]] which causes breaks in the chain of normally existing relations among partial processes.
5. The entities participating in innovation activities are much diversified. These can be production firms, service firms, agricultural farms, scientific organizations, various institutions and also house-holds – the latter as in the model of user-driven innovation [67].
6. Many production enterprises now are parts of more or less formalized networks. A networked character of firms and institutions, and of the cooperation among them, is favorable to atomization of the innovation process. This is consistent with a general observation that today, business is more and more vulnerable to decomposition into independent modules or components that are able to merge in various configurations [89].
7. Certain activities which can be parts/fragments of the innovation process take place in network, that is, somewhere in the world. A new knowledge as the result of collective thinking arises in network, especially on Internet platforms. Here we mean not only crowd-sourcing as a tool of knowledge exchange. In the case of new ICT products, practically the whole innovation process – except for R&D – can be conducted via network [e.g., Linux].
8. The innovation process more and more often is <u>not</u> a continuous, closed and coherent process with an easy-to-identify beginning and end. For example, in the case of open innovation it is hard to determine where and when this process has started. Sometimes it may not finish with commercialization.

As seen, it is even difficult to speak here about a 'process' by definition.

The multi-process model of innovation, where the following conventionally named processes <u>can</u> be included, looks as below [47]:

Ideas + R&D + Transfer + Implementation + Commercialization + Diffusion

Each of the six components creates a new knowledge that has a certain [partial] value. In this way, an innovation value chain arises. We must, however, explain here that:

[8] See, e.g., Edgerton (2007), Montresor (2001), Weresa (2012). However, a globalization of innovation is a broader notion.

- These are not phases/stages of the innovation process, but rather processes creating contemporary innovation activities.
- This is a non-linear mechanism: sometimes another sequence of processes may happen. For instance, during research - by coincidence - an idea can appear for the new product, earlier not taken into account.
- Certain processes, e.g., 'Ideas' and 'R&D' can occur in parallel.
- The actions making up knowledge transfer and innovation diffusion are not typical, indigenous workings being parts of the innovation process but they accompany it.
- In the case of a concrete innovation, not all processes must take place; some of them may not exist. For example:
  1) if a new scientific and technological solution is the result of the R&D work conducted inside the firm, a knowledge transfer will not take place,
  2) if the firm has bought a technological license, which is a mark of transfer, then idea generation and scientific research are not needed. Perhaps some post-license work will be necessary,
  3) as far as process innovation is concerned, its commercialization will not happen when a new manufacturing technology stays in the enterprise,
  4) innovation diffusion, here understood as a spreading of a given innovation among other producers-followers, does not have to occur and sometimes it doesn't occur.
- Finally, the only process that must take place is a production implementation because it determines whether technological innovation appears or not.

As seen, this model represents a process approach to innovation. In the model, each body participating in a given process may be treated as an intermediate client. This can be, e.g., a research organization, an industrial enterprise implementing a new solution and a firm launching a new product into the marketplace. In turn, a final client here will be a consumer or another customer [enterprise, institution or another organization].

To summarize, this is a simplistic outline of the multi-process model of technological innovation. It needs to be polished up and developed. Especially, inter-relations between particular processes creating the value require further research. Nevertheless, the presented model may be useful in improving the management of contemporary innovation processes.

5. Challenges to be faced by innovation managers

As mentioned earlier, innovation nowadays is more and more often not the result of one single innovation process/project, but of a set of partly independent processes or projects. This fact entails certain implications for practice, especially new challenges to be faced by the managers of innovative activities in industrial enterprises. In this section, we focus only on some of the challenges in the context of the multi-process model.

There are at least two major dimensions/perspectives that can be taken into account here: [1] an innovation type from the point of view of its novelty level: radical or incremental and [2] a firm size: small & medium-sized enterprises [SMEs] or big & giant enterprises[BGEs]. The main difference between the two types of the change is that – in opposite to an incremental innovation - a radical one[9] requires a new business model [13; 35; 79; 87]. This is a big challenge for company managers. While the main difference between the two types of firms is that – in contrast to BGEs - small and medium-sized enterprises usually do not possess in-house R&D competences or infrastructure. The considerations below mainly refer to big and giant enterprises.

A starting point of all decisions and actions in innovation management should be a permanent, attentive observation of what happens in a given field [market, sector] in the world and in forecasting what may happen in the future. In open innovation, the issue of choice appears when a firm is starting to look for appropriate external knowledge. This is a very responsible task because, according to [83], the chosen pathways can quickly become effectively irreversible.

First of all, a decentralization of the innovation management is needed [75]. Here we mean a delegation of duties and entitlements to the subjects/entities running particular activities, together with a relevant allocation of resources among various processes. Let's notice that for [13], the allocation of resources and the management of innovation are both sides of the same coin.

The range of those subjects' independence in this area should be relatively broad because their responsibility is relatively big. For example, it may sometimes happen that someone else will be responsible for gathering and consulting ideas from Internet; someone else – for the R&D work being conducted in the

[9] Or disruptive (Christensen, 1997) or niche innovation (Geels and Schot, 2007).

country or abroad; someone else – for production implementation of a new product at the place of the firm's residence; and someone else – for the product launching into the marketplace. In connection with this, the highest rank should receive the supervision over those persons or activities, which is impossible without an effective, many-sided communication among them, especially via social media.

Network relations make the coordination of innovative activities easier. According to [6], the main coordinator or integrator of 'the innovation network' should be an innovating firm. For instance, a cluster of enterprises may create such network with one of them being the integrator. The concept of creative factory by [28] may be helpful here.

Innovation is by nature a risky activity. Therefore, [78] find that innovation management is closely linked to uncertainty management. Due to the fact that additional uncertainty arises as the result of a dispersion of this activity,[10] an ability to undertake and manage a risk becomes necessary. Contemporary innovation needs brave leaders.

A relevant innovation leader is permanently needed to ensure an effective management of the mentioned team game. [4], 6; 16] also think that innovation needs a strategic leader. According to [17], innovation more and more often will be an effect of the firm's collaboration with the environment, and its managers will have to accept that they more seldom will assume full control over these processes in their enterprises.

According to [16], innovation requires a special type of leadership. Not all leaders are fit to be innovation leaders. There exists no single pattern of leadership in innovation. The author divides the innovation process into two big conventional stages. The chairmanship <u>in the first phase</u> – from idea to conception, where creativity and the ability to take risks count – demands fundamentally different personality predispositions and another style of leadership than carrying out such functions <u>in the second phase</u> – from conception to product launching into the marketplace, where discipline and acting speed count [*ibidem*, p. 9]. Finally, he concludes that various innovation strategies require different types and styles of leadership.

Due to the mentioned atomization of innovative activities, nowadays, innovation can't emerge without a skillful, many-sided science-technological cooperation among various entities. Trust in partners is the basis of such collaboration. For instance, trust is needed because there appears the issue of 'collective property rights' [75] as a key challenge for managers. Trust increases through experience with interactions among firms and other actors [30]. Therefore, an effective management of this cooperation is so important but very difficult due to a big dynamics of the present inter-organization relationships [58]. Here the managers can make use of achievements in the theory of management of inter-organizational relations [see, e.g., 1; 40; 57].

A key point here is the issue of intellectual property rights [IPRs]. Such a big importance of IPRs for managers within open innovation, results from two reasons: <u>Firstly</u>, there is a need for an effective protection of IPRs being the firm's important asset, especially because sometimes they are made available free of charge, for instance, in the ICT sector [85]. <u>Secondly</u>, according to the recent studies, IPRs are used as a coordination mechanism in the firm's cooperation with other entities during innovation activities [37; 77].

One of characteristic features of innovation activities is the fact that research project management contains a set of actions which – according to [52] – are not fully defined and sometimes only sketched out. Consequently, such methods as the management of competences, talents and knowledge come to the fore in the coordination of research projects. If needed, there is a rich world's literature on project management to be used here.

The open innovation model is based on knowledge flows between the firm and other actors on the innovation scene.[11] A modern innovating enterprise should make use of so-called network reserves or network capital [31; 36]. These resources can be defined as interactions and relations – being used by organizations to obtain knowledge – that can exist in formal or informal knowledge alliances favorable to innovation [55]. These alliances are one of many forms of scientific-technological cooperation, and the knowledge emerges in the course of various processes creating the innovating activity. On the basis of

[10]As remember, Rip *et al* (2010) warn that distributed innovation means some loss of control for central actors.
[11] The concept of the innovation scene, based on the Triple Helix model by Etzkowitz and Leydesdorff (1995), was presented in Jasinski (2003).

empirical research among 83 British firms, [36] showed that access to network reserves in the form of knowledge alliances is positively correlated with their innovation performance.

So, network creates a kind of innovative environment containing certain knowledge resources that arise during partial innovation processes. Afterwards, this knowledge is 'thrown' into network. Such behavior is favorable to the innovation openness but, at the same time, it causes the mentioned atomization of the innovative activity into partial processes. Open innovation, in turn, is accompanied by such modern ways of supporting action as outsourcing, open source, crowd-sourcing and crowd-funding. They may be used by managers to support relevant innovative activities both in BGEs and SMEs but rather in smaller firms [48].

In the case of the SMEs sector, small and medium-sized enterprises who want to be innovative, often suffer from a lack of cooperation with other entities; they feel lonely [see, e.g., 22; 49; 50; 61; 82; 86]. Such firms need to forge good partnerships to innovate. So, a *Partnership for Innovation*, where various partners /stakeholders may participate, seems to be a kind of remedy for dispersed, partly autonomic, de-integrated innovation processes. The model of partnership for innovation has been formulated by the author [49].

6. Conclusions

Traditionally, innovation is usually seen as a process consisting of several phases/stages from the viewpoint of the firm. However, there exist substantial differences between the phases, various process configurations, various types of the innovation process and various innovation pathways. Moreover, innovation nowadays becomes open, distributed and more diverse.

As we have tried to prove in this paper, a contemporary innovation more and more often comes as a result of a quite loose set of dispersed processes and not of a put-in-order, several-phase innovation process. So, the question - *Does the innovation process per se still exist?* - seems justified. In this situation, a new conceptualization of this process is needed.

The innovation process *de facto* is a combination of dispersed processes, partly independent, very diverse and complicated. In our view, the concept of distributed innovation refers to the notion of such set of processes. However, we don't mean that innovation is the result of a complex set of activities inside the organization because innovative processes today go far beyond the firm.

Innovation, as a fragmented and dispersed combination of processes, brings many troubles for managers in industrial enterprises. The concept of the multi-process model of innovation may be helpful for them to face new challenges caused by those troubles. This is a kind of school of thought that should, as soon as possible, dominate over the actions being undertaken by the managers engaged in the innovative activity. Therefore, the multi-process model presented in this article needs to be further polished up and developed. Notably, interrelations between particular processes creating the value require further research.

Table. Basic differences between R&D, implementation and commercialization

Processes	Nature of actions	Specialization of executors	Sphere of activities	Executing entity
1) Research and Development	creative, intellectual	scientists, researchers	R&D	university, research institute, industrial lab
2) Production implementation	close to production operations	workmen, production engineers	Production	production firm
3) Commercialization	marketing	marketers	Marketplace	sometimes another firm

Source: compiled by the author

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LOCAL ENERGY COMMUNITIES AND SMART ISLANDS: KEY DRIVERS FOR EUROPE'S TRANSITION INTO A RESILIENT AND SUSTAINABLE ECONOMY

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Abstract
Southern EU countries such as Greece, have a huge potential to drive Europe's transition into a resilient, sustainable and inclusive economy adapting to the challenges of climate change through local communities, as small islands are. Promoting the autonomous production of renewable energy on small islands, together with water conservation and food production, would enable them to benefit more effectively from the comparative advantages inherent to the ecosystems of each island, thus boosting economic growth and exchanges across Europe. At the European level, the progress made to foster sustainable energy production has been considerable, especially in terms of cooperation. Future policy measures should not only take into consideration innovation technologies and also social, financial and environmental factors, joining efforts from the civil society, the public sector and the academics.

Keywords
Energy sustainability, Climate change adaptation, Local energy communities, Smart islands

1. Introduction

Southern EU Countries such as Greece have a huge potential to drive Europe's transition into a resilient, sustainable and inclusive economy through local energy communities and smart islands, thus adapting to the

challenges of climate change and an economy in continuous transition. Today, most islands in the European Union face high energy costs and other problems when it comes to security of energy supply. To a large extent this hampers economic growth and employment on the islands. As a consequence, thriving economic sectors, which consume significant amounts of energy, do not leave much energy for other purposes. For example, tourism is a key sector for many European island economies, but it creates a seasonal energy demand which puts a strain on natural resources and infrastructures. Promoting the autonomous production of renewable energy on these islands, together with water conservation and food production, would enable them to benefit.

1. Policy Context and Problem Analysis

Today, most islands in the European Union face high energy costs and other problems when it comes to security of energy supply. To a large extent this hampers economic growth and employment on the islands. As a consequence, thriving economic sectors, which consume significant amounts of energy, do not leave much energy for other purposes. For example, tourism is a key sector for many European island economies, but it creates a seasonal energy demand which puts a strain on natural resources and infrastructures.

Promoting the autonomous production of renewable energy on these islands, together with water conservation and food production, would enable them to benefit "Promoting the autonomous production of renewable energy on islands, would enable these to better benefit from their comparative advantages." more effectively from the comparative advantages inherent to the ecosystems of each island, thus boosting economic growth and exchanges across Europe. Such a development is, however, often hampered by insufficient capacity to produce their own energy as a result of a lack of financial means and know-how.

On a positive note, various practical and successful examples for cooperation among islands can be found in Greece (especially the 'Smart Islands Initiative'; see info box) and at the European level (such as the European Island Networks, the EU project 'Promoting Renewable Energy Sources Integration for Smart Mediterranean Islands' or the Smart Islands Declaration, signed in March 2017 in the European Parliament). Most importantly, however, is the EU-wide 'Pact of Islands', a political initiative with 117 EU island signatories. This is similar to the Covenant of Mayors for Climate and Energy, but, naturally, focused on islands' intrinsic needs and characteristics. The Pact of Islands enjoys the official recognition of the European institutions and engages island authorities across Europe in meeting or going beyond the EU's 2030 climate and energy targets by developing and implementing Sustainable Energy Action Plans specific to the islands' needs and capacities.

The European Commission has also been acting as key driver for enhancing the economic and energy situation of islands, for instance through its 'Clean Energy for all Europeans' package (seeking to establish an EU-wide initiative bringing together all EU islands to accelerate the clean energy transition) or the 'Valletta Political Declaration on Clean Energy for EU Islands' of May 2017. In this Declaration, the Commission and 14 EU member states underlined the huge potential of islands, recognising them as main actors for innovative energy solutions and as destinations for energy investments.

At the global level, the historic Paris Agreement (reached at COP21), has placed special emphasis on the need to strengthen the role and capacity of local authorities in the fight against climate change, especially underlining the vulnerability of islands to climate change. The important role of islands in the transition towards clean energy production, thus enhancing resilience and mitigating risks, was also mentioned.

Taking into account all these developments, European islands are facing a unique window of opportunity to demonstrate worldwide their contribution to a low-carbon, circular and sustainable model of development. At the same time, they can create an exemplary model that respects the limits of islands as much as global ecosystems and available natural resources. That said, European islands need more support at the European and national levels to better take advantage of their often promising conditions in terms of clean energy production.

2. Policy Recommendations

Overall, the progress made to foster sustainable energy production has been considerable – especially in terms of cooperation at the European level. Yet room for improvement remains. Firstly, European member states should review the European Energy Strategy and develop a policy programme aimed at better funding local energy communities and small islands with the potential to become 'smart' and autonomous in their energy production. In light of the developments outlined above, the political support of the EU is a tremendously significant factor. European islands are very diverse in terms of their location, geographic and climatic potential, size and population. As a consequence, a 'one size fits all' programme cannot be the answer. Instead, there is a need for tailor-made solutions, underpinned by general principles for all parties involved.

Secondly, local island administrations need to be provided with tools and competences for assessing the potential of renewable energy sources on their islands. This would allow them to create sustainable local economic growth and to ensure a high quality of life, security of supply and energy services for the local population.

Therefore, smart and integrated solutions for the management of infrastructure, natural resources and the environment as a whole should be implemented. At the same time, innovative and socially inclusive governance and financing schemes need to receive more support. Consequently, it is necessary to further connect European islands via an EU-wide network to exchange on best practices for sustainable energy production.

Thirdly, future policy measures should not only take into consideration technological aspects, but also social, financial and environmental factors. In the long-term, the upgrading of the necessary energy infrastructure can only be achieved when there is a broad-based acceptance for this among the local communities. To gain stronger consent within the local population – which is very often a problem when new infrastructure is built – the establishment of 'hybrid technologies' could be an important step. This combines several renewable energy technologies (e.g. wind and hydroelectric) and therefore adapts to the individual resources and needs of each particular island. Initial experience with this technology on 'smart islands' has been very promising and for this reason an extension of their use seems more than advisable. Furthermore, in order to make sure that infrastructure investments are funded in a sustainable way, the European institutions should initiate and strengthen project-relevant cooperation with all types of credit institutes and banks, helping to foster the concept of smart islands in the long-run. This would help to generate the financial support needed for the promotion of these projects from both public and private investors.

Finally, under no circumstances should improving the energy production harm the local economy (first and foremost the tourist industry) but, rather, foster key local sectors as well. Smart islands should therefore become a role model for 'green tourist destinations'. It is indispensable for all stages of planning to take into consideration that islands and their marine waters are unique ecosystems that require special attention during infrastructure planning and growth.

3. Conclusions

European islands and local energy communities have the potential to be the architects of their own energy transition. Strengthening sustainable energy production at the local level and connecting innovative islands at the European level will contribute significantly to a more sustainable, more secure and more efficient energy production in the EU.

With their strong sense of community and their territorial potential, they are able to create sustainable local economic growth and ensure a high quality of life, security of supply and energy services for the local population, for the benefit of society and the economy, bringing thereby wellbeing, growth and jobs.

Local administrations need to be provided with tools and competences for assessing the potential of renewable energy sources on their communities. Financial support is needed for the promotion of these projects, for both public and private investors.

Tailor-made "hybrid technologies" and smart integrated solutions should be implemented for the management of the infrastructure and the resources. "Green tourist destinations" should be promoted to foster key local sectors, requiring special attention to the ecosystems during all stages of planning.

A policy programme should aim to better funding local energy communities and small islands with the potential to become 'smart' and autonomous. Future policy measures should take into consideration not only innovation technological aspects but also social, financial and environmental factors, enabling international triple helix interactions where civil society, governments, academics, innovators, industry, entrepreneurs, investors, and policy makers engage to foster research, innovation, competitiveness and growth.

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DIGITAL INNOVATION AND OPEN DATA HACKATHONS SUCCESS: A COMPARATIVE DESCRIPTIVE STUDY

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In the global market the use of digital services has been increased and companies and national bodies are required to deliver new services to customers and increase value. Hackathons are events where individuals from different fields cooperate to develop applications that will offer value to citizens establishing a win-win situation for all involved bodies. Despite the significance of hackathons, previous researchers have studied the motivations of developers and the challenges of open data hackathons but limited studies have focused on the preparation and evaluation of these contests. Thus, the purpose of this paper is to identify the challenges that can be faced by organizers of open data hackathons and innovation contests suggesting solutions in order to minimize them. Six case studies of open data hackathons and innovation contests held between 2014 and 2018 in Thessaloniki were examined. The innovation-driven hackathon pattern was applied in order to show how the process of hosting a hackathon event can be stimulated within a public institution and, particularly how challenges can be overcome. The results of this paper share practical experience with academics and researchers by providing new insights regarding to the preparation, the implementation and the evaluation of contests.

Keywords
Innovation, Open Data, Hackathons, Business Ecosystems, Entrepreneurship

1. Introduction

In the global market the use of digital services has been increased and companies and national bodies are required to deliver new services to customers and increase value [2]. Open innovation is one type for democratized platforms that allows resource allocation, the collaboration among customers, organizations and developers. Public institutions and companies plan and implement strategies for open data in order to increase economic value, efficiency, citizen participation, innovation and augmented products and services [5, 10, 19]. Hosting hackathons provide many advantages to companies and government institutions that aim to improve their innovation process due to pressures from digitalization, shorter product lifecycles and new competitors from all kind of industry segments [4].

Hackathons are events where individuals from different fields cooperate to develop applications that will offer value to citizens establishing a win-win situation for all involved bodies. Unfortunately many applications that have been developed in hackathons are abandoned just providing an open data access is not enough to increase economic value. Open data initiative must be part of a whole ecosystem in order to improve productivity of existing companies or government institutions and enable the creation of innovative products and services through the use of enabled IT platforms [3, 18]. Despite the significance of hackathons, previous researchers have studied the motivations of developers and the challenges of open data hackathons but limited studies have focused on the preparation and evaluation of these contests. Thus, the purpose of this paper is to identify the challenges that can be faced by organizers of open data hackathons and innovation contests suggesting solutions in order to minimize them. Six case studies of open data hackathons and innovation contests held between 2014 and 2018 in Thessaloniki were examined. The innovation-driven hackathon pattern was applied in order to show how the process of hosting a hackathon event (from idea generation to the creation and evaluation of prototypes) can be stimulated within a public institution and, particularly how challenges can be overcome.

This paper is organized in four sections. The next section presents theory related to open data challenges and a description of the innovation-driven hackathon pattern. Section 3 presents the methodology of this survey. Section 4 discusses the results of the implementation of the innovation-driven hackathon pattern in hackathons. Finally, Section 5 provides conclusion and suggestions for future research.

2. Theoretical Background

2.1 Open Data Challenges and Business Ecosystems

Open data are used in readable formats by institutions or citizens in order to develop systems, applications, new products or services. They are based on open standards and tools without fees. However, they are available through various formats and third parties have to correlate them, analyze them and extract information relevant to the objective of each use. Many challenges are addressed in order to realize the open data value potential such as the identification of relevant data, the quality of data, the integration of data, the availability of open data sources, the lack of metadata and standards, the availability of tools for collecting and sharing data, the development of standards in order to expedite the integration of data that are distributed in multiple platforms. Thus, it is important for entities in the ecosystem to develop open data solutions based on service-centric approaches that will allow the development of applications including data analysis services, APIs, reliability of available data services [5, 9, 12, 14, 17].

Actors participating in business ecosystems (e.g. companies, institutions, data providers, customers, competitors, local incubators, investors and universities) cooperate to support new products or services and satisfy customers' needs. They are responsible to promote innovation through funding programs, hackathons, and investments as well as help developers to use data in order to produce solutions for the market that provide practical benefits to users [8, 9, 15]. Companies usually host hackathons because there are many benefits for companies that organize or participate in a hackathon.

2.2 The Innovation-Driven Hackathon Pattern

Hackathons are events where different actors cooperate to create, gather, and evaluate the first ideas and prototypes in order to provide added-value to customers. They share ideas, experiences and limitations and get feedback from experts and researchers in order to develop an improve market applications. Organizing hackathons is a challenge for companies because the output is a prototype which attracts employees or community and the company considers how to proceed with it. The company needs a plan in order to decide how to develop it, test it to customers and launch it to the market. For new kind of solutions, such as open data platforms, companies collaborate with the actors of business ecosystem in order to develop the marketing strategy or the standard product development process [4].

The innovation-driven hackathon pattern, adopted in this paper, presents these organizational challenges and focuses on the aspect of "creating something new" during hackathons. This pattern consists of four aspects named; context, forces, problem and solution. These disciplines are presented in Table 1.

Table 1 Aspects of the innovation-driven hackathon pattern.

Aspects	Description
Context	This aspect describes the activities of a company or a public institution and the reason for which it adopts innovation solutions.
Forces	This aspect refers to the internal forces of a company or a public institution that affect the development of a new product or service.
Problem	This aspect describes the problem that faces a company or a public institution and the need to allocate the right people who are able to think using a customer-centric mind-set and generates innovative ideas, develop prototypes, and consider market aspects.
Solution	This aspect describes the hackathon which is hosted by a company or a public institution in order to invite people to participate, collaborate, and develop prototypes giving a solution to the problem.

3. Methodology

Six case studies of open data hackathons and innovation contests held between 2014 and 2018 in Thessaloniki were examined. The innovation-driven hackathon pattern was applied in order to evaluate the challenges and the success of each contest. These events last 1-3 days and organizers are responsible for the planning of the contest (e.g. timing, physical location, technical infrastructure, and logistics) since the day of execution. Then, participants develop their applications which are evaluated by the jury committee. The purpose of hackathons and innovation contests in Thessaloniki is to inform and encourage developers and citizens to use open data and applications which are developed based on data in order to increase the benefits both for participants and citizens. Based on Figure 1 the main phases of hosting hackathons in Thessaloniki are definition of goals, planning and

organizing the hackathon, execution and post-event evaluation [1, 11, 13, 16, 18]. These phases and their activities are presented in Table 2.

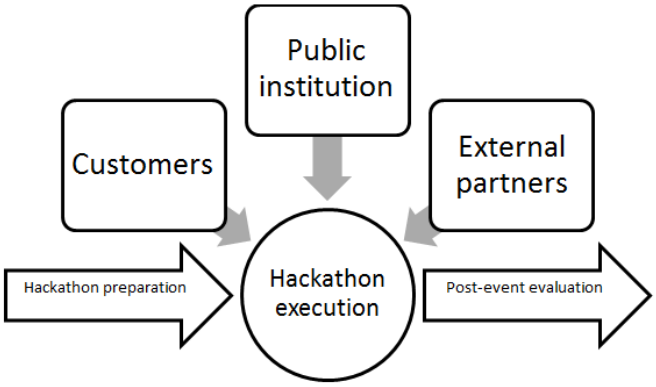

Figure 1 Phases for hosting hackathons.

Table 2 Phases and activities for hosting hackathons.

Phases	Activities
Definition of goals	Definition of goals and objectives of the hackathon
Planning and organizing the hackathon	Announcement and invitations to encourage participation Preparation of networking facilities and small breakout conference rooms Marketing campaign
Execution	Technical infrastructure Food and Coffee Ideation and team building
Post-event evaluation	Participants have to decide how their idea could be further developed

4. Results

Table 3 presents the application of innovation-driven hackathon pattern in Thessaloniki's hackathons. Six open data hackathons held between 2014 and 2018 in Thessaloniki were examined. "Hackathess", "Apps4Thessaloniki" and "Apps4thessaloniki tourism edition" were organized by the Municipality of Thessaloniki in cooperation with the Open Knowledge Foundation Greece, and the Urban and Regional Innovation Research unit. "Afixis Hackathon" was hosted by the NGO Afixis. Finally, universities in Thessaloniki hosted two hackathons; "Let's have a Hackathon!" was organized by the Aristotle University of Thessaloniki, and "Datathon 2018" was hosted by University of Macedonia. In each hackathon 11-25 teams consisting of 2-4 developers/students participated and developed their projects.

Table 3 The application of innovation-driven hackathon pattern in Thessaloniki's hackathons.

Hackathon	Context	Forces	Problem	Solution
Hackathess	• It is organized by the Municipality of Thessaloniki • Citizens expect to improve the quality of their life	Citizens' needs to use digital services	The development of new applications in order to improve citizens' life, based on open data	Solutions that improve citizens' life and the effectiveness of Municipality
Apps4 Thessaloniki	• It is organized by the Municipality of Thessaloniki	Creation and sharing open data among actors in	The creation of web and mobile applications that improve different	Mobile applications that help tourists,

	• Citizens expect to improve the quality of their life	Thessaloniki's ecosystem	functions of the Municipality and the city	citizens, increasing innovation and entrepreneurship
Apps4 thessaloniki tourism edition	• It is organized by the Municipality of Thessaloniki • Tourists expect to improve their experiences	• Creation of a smart city • Creation and sharing open data among actors in Thessaloniki's ecosystem	• New opportunities for tourists • New experiences for tourists • Benefits for tourists	Mobile applications for tourists
Afixis Hackathon	• It is organized by Afxis • Organizers expect to develop innovative educational programs	Education of students using IT platforms	Creation of innovative educational programs for students	Smart devices
Let's have a Hackathon!	• It is organized by the Aristotle University of Thessaloniki • Academics expect to develop digital capabilities	Digital transformation	Development of digital capabilities	Digital devices
Datathon 2018	• It is organized by the University of Macedonia • Academics expect to conduct statistical research using open data	Use of data for conducting statistical research	Development of ideas and applications to improve daily problems	Applications using open data

The prototype is focused on users' needs and provides benefits for them, but, certainly, also considers its commercial aspects. Therefore, different skills and experiences are necessary and internal or external open-minded and hands-on people participate in hackathons in order to develop applications. The solution design is not a viable product, but a prototype which only include a minimum set of key features, and it has to provide value to its potential customers and allows acceptance tests [4].

Finally, the main part of each hackathon ends with a final pitch in front of a jury committee in order to select the most innovative prototypes which should be further developed in order to become a viable) product for customers. In each jury committee experts, academics, potential customers, mentors, investors, senior managers of local companies and members of the Municipality of Thessaloniki participated. In addition a wider audience, including other colleagues and test customers, can be invited and involved in the iterative approach at the beginning and in the decision-making process at the end [18].

Based on the innovation-driven hackathon pattern the best people from within or outside of the public institution are invited to a compact event. Developers with different skills and experiences cooperate, create a team and compete with other teams in order to generate new ideas, create prototypes and develop new solutions. It is a big challenge for them to create a team which will work together in such a short timeframe and get useful results. People who have professional experience with team-building processes, agile methods and workshop organization have to prepare and guide carefully these teams. Furthermore, trust among the members of each team is necessary because it is difficult to work together with people who may have never worked together before and be able to produce useful results so quickly. However, people focus and work highly concentrated in a "condensed manner" due to the short timeframe that creates a kind of urgency. In addition, experts and their

superiors can be easier convinced to get their support for a few days than to help teams to develop a project that will end in few months. In hackathons there is a risk that follow-up activities will not be done properly and never be finished. When the hackathon event will end, experts have to support teams to expand their applications. Starting with a concept or prototype additional software development activities are necessary in order to develop a solution with a minimum set of features and provide it to customers [4].

Although, these contests were successful and new applications were created, an important finding is that organizers did not take feedback by participants in order to improve future events. Furthermore, the organizing committee did not support the winners to expand their applications and create startups. They should engage mentors who support participants to get funding and launch their applications to the market [11, 13].

5. Conclusions

The analysis of the innovation-driven hackathon pattern has shown how the process of hosting a hackathon event (from idea generation to the creation and evaluation of prototypes) can be stimulated within a public institution and, particularly how challenges can be overcome. Many organizations have organized hackathons. However, all of them are not successful [6, 10]. It is important to identify clear goals and prepare a professional hosting of the event as well as of follow-up activities in order to develop and launch a viable product to the customers. Sponsorship is required in order to find out the right people that will be involved in the hackathon and support follow-up activities such as developing, launching, and marketing an innovative product or service [11, 13].

This paper can be of interest to organizers of hackathon contests because they could be aware of the challenges that influence the implementation of these events. As earlier mentioned, the challenges that are related to the preparation and implementation of these events are not well defined, but they play an important role in the outcome of hackathons. Practitioners who focus on the improvement of these factors can overcome organizational challenges and speed-up the innovation process in hackathons' implementation. Furthermore, the results of this paper have practical contribution for academics and researchers because this paper provides new insights regarding to the preparation and the implementation of hackathons. It is clear that there is not a single way of how to organize a hackathon or an innovation contest, but the whole set-up must be defined by specifically for the needs of each public institution and even adapted for each specific use case. A more depth analysis of the innovation-driven hackathon pattern and experiences of its application would help practitioners to examine how it could be applied to each hackathon because hackathons differs in purpose, preparation, execution and follow-up activities.

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A STUDY OF BUSINESS CASES FROM RESEARCH GRANTS IN EUROPE FOLLOWING THE TRIPLE AND QUADRUPLE HELIX APPROACH

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Abstract
Over the years, significant amounts have been invested in research grants, in Europe and abroad. Specifically, in EU, nearly €80 billion of funding have been or are to be granted from 2014 to 2020 via the Horizon 2020 (H2020) funding programme, focused but not limited to research and development (R&D) breakthroughs and world-firsts. However, few of the projects funded so far are successfully brought to market, and much less to government adoption. This paper presents a comparative study of three business cases from research grants under a triple/quadruple helix approach. It studies the underpinning global and European trends leading to success, the markets, the domains, the applications and stakeholder engagement. The study considers highly innovative domains namely e-health, elder care, smart cities, social media monitoring, leading to insightful observations and hoping to spark further triple-, quadruple- helix successful business cases. By mapping diverse business cases to the quadruple helix framework, we show how important collaboration between diverse stakeholder groups is, in order to bridge lab to market.

Keywords
Research grants, H2020, quadruple helix model, triple helix, R&D, stakeholders, business cases

1. Introduction

Research and innovation have been identified as the core of the Europe 2020 Strategy to put Europe at the forefront of sustainable growth. Almost €80 billion of funding is available over seven years (2014 to 2020). However, a European Commission study [1] presenting preliminary data analytics on H2020 project outputs, shows that only 15.5% of participating firms are introducing innovations new to the market (covering the period of the project plus three years) and even fewer (13.9% of participating firms) are introducing innovations new to

the company [1]. In the context of tighter budgets and more public attention to the effectiveness of EU-funded research, there is a need to demonstrate and strengthen the performance, impact and added value of EU programmes. Support for market-creating innovation is also identified as a key area for improvement by the same study.

2. Triple and Quadruple helixes' models for open innovation

The Quadruple Helix is an open innovation model that encompasses a citizen dimension. It is useful in an innovation process where the citizens' needs are central, as for example in health care and public e-services. This paper aims to identify and analyse the underlying trends, needs, means and methods for the exploitation of EU-funded R&D projects and bring into focus the triple and quadruple helix model as a means to boost open innovation and market potential. We will examine the role of the four helices onto different business cases a) Carealia, an eHealth for dementia solution, b) Improve My City, a successful eGovernment solution for cities and c) Event Suite, an event planning suite. For each solution we investigate and list underlying trends, ideas, markets, technology, R&D, results and validation, traction and adoption as well as triple/quadruple helix parameters, namely government and society involvement.

2.1. Lessons learnt from business cases of R&D projects under the prism of the quadruple helixes' models.

Carealia uses reliable IoT devices and intelligent analysis to capture behaviors and symptoms of dementia. Pilots in Sweden, Greece, France and Ireland shown nurses operating 5 times faster, customer satisfaction increase and 20% cost reduction [2]. A published year-long trial proved that 3 out of 4 users improved their mood and cognitive state and 1 remained stable, contrary to expected deterioration [3]. It was formed in 2016 after CERTH's coordination of the Dem@Care (FP7 IP - www.demcare.eu) project. To innovate and experiment in real world settings the original consortium of the Dem@Care project has involved all stakeholders (industry, academia, citizens) in triple and quadruple helix but for government. Understanding that co-operation is an increasingly important prerequisite for R&D exploitation Dem@Care created a User Group, a list of organizations interested in creating synergies with the project. This way a partnership with Alzheimer Hellas was formed to pilot and evaluate the developed technologies in real life settings. This partnership is still ongoing with Carealia. Although the project attracted very positive feedback and is currently installed in a limited number of users it has had considerable difficulties to attract private funding and enter market. Experience from Carealia shows that not involving a public authority in the loop can considerably hinder market adoption. As scholars support, lack of awareness by policy decision makers impacts the ability to set up and implement whole system approaches [4]. Involving the right mix of stakeholders can be proved really beneficial to successfully bringing an eHealth technology to market.

Improve My City (IMC) [5] is a platform for managing local issues; from reporting, to administration and analysis. It targets government entities seeking collaboration with their citizens. It is an easy to install integrated solution, which is freely available as open source. The business case originated as a spin-off of the Live+Gov project that has been completed in August 2014 and has been commercially available ever since. The platform is installed in more than 24 cities worldwide. Improve My City showcases how involving all the stakeholders of the quadruple helix model can really boost innovation. Back in 2012 the consortium funded for the Live+Gov project comprised of academia and industry partners. Notably, field trials and exploitation were supported by a committed advisory board from four governmental institutions, ensuring widespread take-up and long-term sustainability of the project results. The developed technologies (and apps) were also evaluated by citizens among which the Municipality of Thermi in Greece. The Municipality of Thessaloniki has also adopted the solution.

The third case is *Event Suite by infalia*, a spin-off company of the Information Technology Institute of the Centre for Research and Technology Hellas (CERTH), specialized in the provision of web and mobile app solutions and tools addressing the needs of the event eco-system. The company leverages big data and social media analytics to capture the pulse of large events and help event organizers comprehend the impact of their events on visitors and attendees. The spin-off was created as a result of a FP7 funded project SocialSensor. Event Suite has been considered as a really promising business venture that eventually didn't take off. Identified challenges related to the transition from R&D expert-driven innovation to quadruple helix models pertain to the fact that open innovation is in contradiction with bureaucratic processes. Governmental support to knowledge-based spin offs is a prerequisite for fast market entry. Policies and measures for supporting user-oriented innovation are only in their infancy. Another insight is that user/customer involvement should be ensured across all stages of development. Understanding the needs and wants of customers and also what they are willing to pay for a proposed solution is of paramount importance.

Table 1 Comparative Table of 3 R&D business cases under the prism of the quadruple helix

Project	Business Case	Total Budget	Quadruple Helix Involved entities	Maturity Level	Viability
Dem@Care	Carealia	10,761,967	Universities, Research institutes Industry Civil Society	Market-ready	On-going effort to bring to market
Live+Gov	Improve my City	3,415,024	Universities, Research Institutes Industry Civil Society Government	On the market	Viable
SocialSensor	Event Suite	9,639,593	Universities, Research Institutes Industry Civil Society	Market ready	Not viable in its present form.

2.2. Perspectives from R&D business cases

Technology has put co-creation in the fast lane. In today's knowledge-based economies corporations cannot rely only on themselves to deliver innovation. If not the most, it is definitely one of the best ways to ensure viability by engaging the consumers in the company, increase brand recognition and have tangible results: an increase in sales. In all the examined business cases, co-creation and involvement of end user in the requirements and piloting/evaluation phases has had a leading role with regards to market adoption. Research shows that no involvement of citizens might lead to (a) Products and services not used, (b) Lack of transparency, (c) Innovators and end-users not understanding each other, (d) Frustration and (e) Technical innovation instead of social innovation [6]. Another entity of the quadruple helix model, government also plays a vital role in promoting innovation and entrepreneurship throughout the country or in a certain region. Governments have to understand and support the process of turning science-based 'inventions' into commercially viable 'innovations' in order to spur radical technological change and promote sustainable growth [7]. In both cases of Event Suite and Carealia the lack of governmental support and entrepreneurial training appears to have hindered market penetration.

3. Conclusions

Open innovation creates opportunities for companies to look beyond their traditional R&D boundaries to develop new products and services, expanding their reach and increasing their bottom line. Startups who want to win in today's knowledge economy should leverage open innovation, creative destruction and customer co-creation. Fostering synergies and focusing on knowledge transfer is of paramount importance too. Utilizing the triple and quadruple helix models as instruments tying together innovation initiatives at different scales is expected to increase their overall potential and impact. Startups that achieve in this respect will be distinguished and grow.

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PROTOTYPING WEARABLE DEVICES FOR BOOSTING ENTREPRENEURIAL SPIRIT

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Abstract
With the advances in technology and more applications becoming real-time and embedded, teaching the mechatronics course only theoretically becomes insufficient. Consequently, project-based learning becomes one of the most effective approaches in teaching mechatronics subjects. The main objective of this paper is to present an innovative approach in project-based learning within a mechatronics course for teaching undergraduate students. The project-based learning is presented through student projects inspired by wearable electronics as new trending fields in mechatronics. In this paper, a novel methodology for implementing the project-based learning process was described. The course structure, organization and evaluation are explained. The students' feedback, results and the benefits from the course are also discussed. Conclusions about the project-based learning and its effects in teaching mechatronics among undergraduate students are pointed out.

Keywords
Engineering Education, Entrepreneurial Spirit, Mechatronics, Project Based Learning, Wearable Electronics

1. Introduction

Mechatronics as one of the most innovative engineering field has not only introduced a synergic integration of disciplines such as mechanics, electronics and computer science, but has also turned the engineering education into a design philosophy [1]. Mechatronic systems comprise a basic system (mechanical, electro-mechanical, hydraulic or pneumatic), sensors, actuators and information processing. In general, a mechatronic system consists of three types of flow: material flow, energy flow and information flow. An overall scheme of a mechatronic system is given in Figure 1.

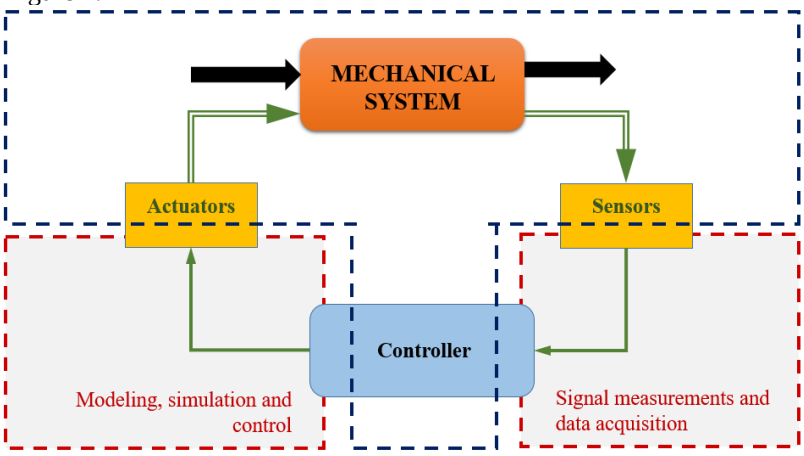

Figure 1. Overall mechatronic system scheme

Mechatronic curricula is a challenging process because it requires creative and critical thinking and also team-oriented skills. There are various methodologies and definitions that have been created to define the mechatronic system design, such as the industrial guideline VDI 2206. This standard gives a definition about the process of developing a mechatronic system: "The development of mechatronic systems presupposes the fully inclusive consideration of the systems, an interdisciplinary way of thinking, a common accompanying language among the developers and usually the use of computer-aided tools." Because of the complexity and heterogeneity affecting most mechatronic systems, a systematic procedure is essential. Also, VDI 2206 presents the "V-model"

as macro-cycle which is a graphical construct used to connect the model-based learning design and the development methodology, as shown on Figure 2.

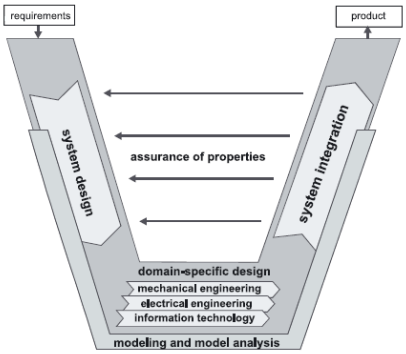

Figure 2: "V-cycle" according to VDI 2206 [2]

Project based learning (PBL) presents a methodology for applied engineering education which is created to allow students to develop projects which are applicable to the industry [3]. Apart from the classical teaching methods, project-based learning provides the students a chance for a hands-on, real industry problems solving which will make them more competent and skillful for a further job in the dynamic and demanding engineering labor market [4]. The project-based learning opens up new wider ways of creative thinking, develops their skills in decision making, time management and ultimately most important team working [5]. Project oriented education strengthens the development of the soft skills of the students in terms of making their own decisions and taking responsibility in the process of creating an original idea. At the end of the process, their motivation and self-esteem get drastically higher because they feel successful in designing real projects [6]. The final result of practical project implementation is the integration of applying basic knowledge, specific knowledge and acquirement of new theoretical knowledge, but most important in improving students' practical competences [7, 8].

Within the study program in Mechatronics in the Faculty of Mechanical Engineering in Skopje, students have been involving in project-based learning process in the past 10 years. The project-based learning is implemented through organized projects where students work on predefined tasks that would lead to complete products. In 2010, a project consisting of Universities and EU industry partners has been developed in order to establish connection to the local industry needs [9]. One of the objectives of the project for the Faculty of Mechanical engineering was a development of an autonomous vehicles as a student project industry examples of project-based learning which are presented in [10].

The main objective of this paper is to present an innovative approach in project-based learning within a mechatronics course for teaching undergraduate students on their 3rd year studying on the mechatronics study program. The course "Introduction of mechatronics" is the first mechatronics course that student have while their study. The purpose of this paper is to present a successful methodology for teaching mechatronic by developing goal-oriented student projects within this course in the Faculty of Mechanical Engineering in Skopje.

2. Teaching methodology

To define the mechatronics system design, a method composed of combined knowledge was applied to the mechatronics curricula. The course structure was compiled of 4 segments: theoretical study of the fundamental concepts, LabVIEW software programming, writing a research paper and developing prototype. The project-based learning methodology allow the students to real develop real projects. The applied methods to this mechatronics curricula achieved effective and easier understanding of the overall design and concept of the mechatronics system.

The idea was to introduce project-based teaching mechatronics to mechanical engineering students from Mechatronics study program. There were 30 students divided in 15 teams consisted of 2 people and each team had to deliver a project task until the end of the semester.

At the primary phase, the students were assigned to do a research within the given topic about wearable electronics and choose an interesting segment to further analyze. The goal was each team to produce a prototype and to write a review paper about the subject they have chosen. This made the projects themes more global, challenging and more motivating. Through developing simple, but still attractive and very useful projects, the students have learned the work and implementation of the sensors, actuators and computer programming as a consisting parts of a mechatronic systems.

A period of one week was given to the students in order to explore and read about the topics and to choose an interesting specific problem observed in 5 relevant (not older than 5 years) scientific papers. The teaching assistant and the student assistant presented the students how to proceed the process of searching and exploring successfully in order to find relevant information. They introduced them to "Google scholar" as a searching machine to find important research and review papers. After the first week, the teams presented their ideas in front of the professor and the teaching assistant and explained their vision and plans on how the project will be realized. These ideas were discussed and approved or in some cases modified by the professor. Their resources were framed only in terms of limited time and money. They were allowed to use components only from the Mechatronics laboratory under the Faculty or to spend additional 10 Euros per student and were given a period of 10 weeks to complete the projects. During the working process they were monitored by the teaching assistants who asked for a weekly report about the progress of the work, but were also helping them with certain problems they were facing. They were also analyzing the students' team work and the atmosphere among the team partners. In the meantime, the student assistant was teaching the students software programming in LabVIEW, as a part of the subject content. At the end, the total grade of the project teams in general, and of every student separately was evaluated by the following criteria, as shown on Figure 3.

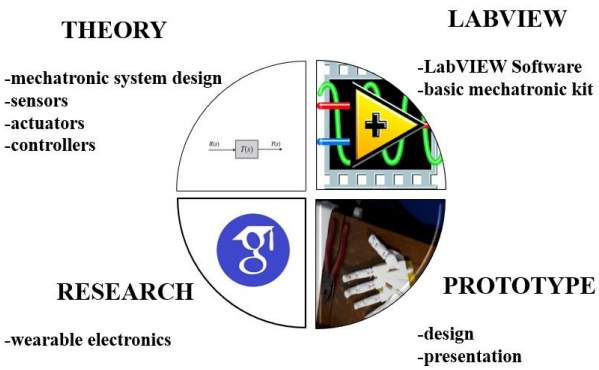

Figure 3. Course structure

In the 8th week of the semester, the students were tested over in theoretical concept. In the 14th week they had another test in form of LabVIEW exercises which contributed with another 25%. The rest 50% were given to the students according to the quality of the review paper they have written and the prototype that they were expected to make at the end of the semester. Every part of the subject was quantified equally with 25%. After the 15th week, the professor and the teaching assistant organized a class where all of the teams had to present their prototypes in front of all the rest. Each team was given 15 minutes to present a PowerPoint presentation about their work and to show their prototypes. After that, they were evaluated by the professor, the teaching assistant, lawyer for intellectual property and the students themselves. Each student was graded according to the percentages from the self-grading and percentages from the test.

Each of the segments of the course structure contributed to upgrading students' skills equally effective, but in different aspects. The theory that they have been taught and afterwards examined helped them in concepts understanding and improving their technical literacy in mechatronic field. They have learned the principles of work of components that one mechatronic system is built of and the physical and engineering processes happening meanwhile. The LabVIEW software provided the students with a hands-on experience in software analysis and interfacing and DAQ analysis which created a virtual image about a mechatronics system function. They were introduced to Google scholar as a way of searching which has never been mentioned or used during their studies. Also, in order to write their own research paper, they were introduced to the key-points of a paper structure and the methodology of writing a paper. When their papers were finished, they were taught how to check them for plagiarism online. On the other hand, apart from the technical knowledge they got through studying the theory and software, they also progressed in developing their soft-skills through their work on the prototype.

3. Case studies

The process of working on the projects resulted in upgrading not only the theoretical, but also practical education, but also their team spirit and soft skills were developed. Through working on a specific project for wearables, their motivation and inspiration for self-proving increased. Wearable devices or simply wearables, are devices that can be worn on different parts of the body that have integrated microcontrollers in order to achieve different functions. Easy to wear, constantly evolving and upgrading, wearable electronics are becoming the new trend.

At the end of the course, they were feeling proud and appreciated because their projects were successful and their prototypes were properly working. The course resulted in different, very prosperous projects. In this paper are presented the inspiration, the idea and the final results from the best 3 of them, shown on Figure 4.

a. Wearables for assisted driving b. Smart glasses c. Smart helmet

Figure 4. Prototypes of the case studies (a. wearables for assisted driving; b. smart glasses; c. smart helmet)

3.1 Wearables for assisted driving

This project was inspired by the in-car usage of wearables is inevitable as many drivers bring their gadgets in the cabin space. With the tendency towards connected cars, investments in car-related technologies such as wearable devices and smartphone apps drastically increases. Also, many of the major automakers adopt the concept of wearable electronics in attempt to enhance the driving experience. This type of devices for in-car use can be exploited for many different purposes. The main one is the safety of the passengers achieved by detecting drowsiness, stress level of the driver, or even identifying theft of the automobile. Prototype of a jacket for assisted driving was constructed. The jacket has multiple functions provided by implemented sensors for breath analysing for toxicity level in the blood, sensor for seat-belt alert and the temperature and humidity in the air.

3.2 Smart glasses

Smart glasses are to glasses as smart watches are to watches—that is, they're a wearable device capable of presenting useful information to the user. The project develops smart glasses that give information about oncoming call, a text message, weather prognosis and GPS information while driving. The smart glasses are a very practical solution and cheap solution to a lot of modern problems. The model contains low-budget electronics such as: Arduino Mini, an OLED display, Bluetooth shield, Li-Po battery and a charging station. As for non-electronic parts, 3D printed plastic casing is used and a mirror to reflect the picture with a small glass screen on which the picture is projected. When fully assembled, the glasses connect with a smartphone using application that sends the information.

3.3 Smart helmet

The main inspiration behind this project is providing safety while driving bicycle using wearable electronics. A smart helmet is a helmet designed for improving the safety of those who use bicycles as a way of public transportation. Its integrated system is designed to provide effective travelling through public traffic and increase the awareness of the others surrounding the bike. The prototype has been categorized as a wearable electronic and uses several smart components that define its functionality. The helmet's main functionality is to provide LED powered turn signalization. The LED lights are connected to an Arduino platform which contains a smart program code designed for these specific functions. On the sides of the helmet there are two touch buttons which are put in place as a way to activate the LED indicators. In between the left and right signal, there is a red STOP blinking LED signal which changes its blinking style depending on the use of the turn signals. This system is compact and easy to use, provides a modern solution to safer and cost-effective public transportation.

4. Soft skills development

The project-based learning conducted within the "Introduction to mechatronics" class is a process of inductive teaching and learning which focused on developing innovative thinking in students. For the students, it is not sufficient to only obtain technical skills and knowledge, but also to develop communication and team-based skills. This approach utilizes real problems, not hypothetical ones and teaches the students how to function in a systematic and progressive way. Besides the classic way of grading and questioning, the course included self-directed learning and learning from the peers. The students were divided in teams and were given limited time and money to construct their project prototype. This resulted in increased sense of responsibility and resource management. Given the task to create a project prototype on a subject they have never read about was very challenging for them and developed their research, problem-solving and critical thinking skills. The team-work upgraded their awareness of discipline and strive to achieve success in order to stand out and not disappoint their team members. They were motivated to deliver the given task in terms of creating the best technical solution, but they also had to pay attention of their relationship and communication with the rest of the students. As a new aspect, they were introduced to academic writing for the first time. Throughout the semester, they were constantly learning and comparing each other's work, which created a positive and healthy competition. The grading was separated in four equally valued parts (theory, software, review paper and prototyping) which tested their capabilities of strategic thinking in terms of organizing the work more effectively, efficiently and systematically. Essentially, at the end of the course the students' feedback was most important. They were feeling self-confident

and stated that they feel like they have improved their knowledge, attitude, values and skills. They realized that engineering, especially mechatronics, is more than just facts and equations.

3. Conclusions

In this paper an innovative methodology to mechatronics course was presented. The main aim of these projects was to implement the project-based learning in the "Introduction of mechatronics" class held in the Faculty of Mechanical Engineering in Skopje. The project-based realization of the subject resulted in being very successful. Based on implementing the project-based learning experiences, it can be concluded that the main benefits of project-oriented education are acquiring basic and specific knowledge and application of the acquired knowledge unlike the traditional education approach. As an overall conclusion from this process is that both teachers and students have to show bigger commitment and responsibility in the process of teaching and learning. The project-based learning have shown to be the most adequate methodology for teaching mechatronics in specific, but engineering in general, because it represents a link between the education and the industry. This way of learning provides the students competences that drastically increases their chances of success in the modern world.
Based on implementing the project-based learning experiences, it can be concluded that the main benefits of project oriented education are acquiring basic and specific knowledge and application of the acquired knowledge unlike the traditional education approach, developing soft skills, entrepreneurship and serious approach on solving a real problem. As an overall conclusion from this process is that both teachers and students have to show bigger commitment and responsibility in the process of teaching and learning.

The work of the team led by the assistant professor, as well as videos from the projects that were constructed at the end of the semester within this class can be followed on http://ms3lab.com/.

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THE TRIPLE HELIX MODEL IN THE BULGARIAN INSTITUTIONAL ENVIRONMENT

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Abstract
The contribution of state institutions to the overall process of development is considered as one of the most challenging problems in today's economies. Therefore, the Triple Helix model, which requires the collaboration of government, educational institutions (the academia), and the business is a valuable instrument to contribute to the development of innovation and therefore it is a problem solving tool for many problematic aspects of economic development and social progress. The aim of this paper is to analyse the application of the Triple Helix Model in the Bulgarian institutional environment by critically discussing its problematic aspects in education, and to propose solutions in support of the successful application of the model.

Keywords
Economic development, institutions, education, social progress, triple helix

1. Introduction

The issue of identifying the contribution of state institutions to the overall process of development is considered as one of the most challenging problems in today's economies. While it is already historically observed that neither complete state regulation, nor the unregulated free market are good for economic development and growth, the role of institutions is constantly being reconsidered in contexts of interrelation and models that require the joint efforts of several players, in order to achieve necessary changes in various aspects of economic life. Hence, the Triple Helix model, which requires the collaboration of government, educational institutions (the academia), and the business is a valuable instrument to contribute to the development of innovation and therefore it is a problem solving tool for many problematic aspects of economic development and social progress.

The aim of this paper is to analyze the application of the Triple Helix Model in the Bulgarian institutional environment, particularly in terms of education, to critically discuss the problematic aspects, and to propose solutions in support of the successful application of the model.

2. Methodology

The methods applied include a literature review of the problem and the Triple Helix model. The problematic zones in the interaction between the government and the educational institutions, the government and the private initiatives, and the academia and the business are identified and supported through data research and analyzes from the National Statistical Institute of Bulgaria, which covers the last 5 years (2013-2018).

3. The university-industry collaboration

3.1 The importance of university-industry collaboration

The collaboration between universities (the academia) and industry (the business in general) is becoming an increasingly crucial component of the national innovation systems both in developed and developing countries. It is known in economic literature as a focal element in the Tripe Helix model (e.g. [1], [2]). In his profound work Etzkowitz wrote: "triple helix is a metaphor for university, industry, and government interacting closely while each maintains its independent identity. The triple helix message is that universities, firms and governments assume some of the capabilities of the other, even as each maintains its primary role and distinct identity" [2]. This collaboration is particularly important in revitalizing economies after periods of tremendous political and economic challenges (e.g. moving from planned economy to market economy, overcoming periods of crisis, introducing regulations to reduce high corruption levels, etc.). It is meant to continuously contribute to the adaptation of the whole institutional system within a given economy so as to achieve considerable improvements in one of the most important factors for achieving economic development – education and improvement of the quality of the human capital.

Guimon [3] claims that although it is useful to examine the experience of developed countries in order to understand the different types of university-industry collaboration, along with the role of public policy in fostering such linkages, there is a significant difference as to the application of the model in developing countries, because they face greater barriers to such forms of interrelation and thus require a different approach. He further observes that the collaboration between universities and industries is critical for *skills development* (education and training), *the generation, acquisition, and adoption of knowledge* (innovation and technology transfer), and the *promotion of entrepreneurship* (start-ups and spin-offs). To this end, the benefits of university-industry linkages are wide-reaching as they can help coordinate R&D agendas and avoid duplications, stimulate additional private R&D investment and exploit synergies and complementarities of scientific and technological capabilities.

Therefore, university-industry collaboration can also expand the relevance of research carried out in public institutions and thus, foster the commercialization of public R&D outcomes. This ultimately leads to increase in the mobility of labour between public and private sectors [3].

Furthermore, the collaboration between the academia and the industry might be formal or informal, from formal equity partnerships, contracts, research projects, patent licensing to human capital mobility, publications, and interactions in conferences and expert groups [4]. Companies and universities find it mutually beneficial to collaborate because private firms are constantly adopting open innovation strategies in order to better access and integrate external sources of knowledge. On the other hand, the strategic mission of universities since 1990s has moved beyond the tradition of teaching and research toward a new mission, related to better addressing the needs of industry and contributing directly to economic growth and development. Hence, the three university missions have given rise to three distinct concepts i.e. *teaching university, research university, and entrepreneurial university* [3].

Yet, when exploring the link between the academia and the business as well as the role of public policies applied by government institutions to strengthen that link, it is of primary importance to distinguish the differences in the priorities economies have when they are at different stages of their development and adapt institutional structures and policies accordingly. Developed and developing economies experience different economic issues related to economic growth, income, unemployment, etc. and this respectively leads to different impacts on the demographic structure of the population, its educational opportunities and hence the overall development of the human capital. The same relates to countries that have gone through long periods of transition, like Bulgaria – from 1989 to 2007 (the end year is chosen here as a cutting edge period when the country was accessed to the EU, although there is no official data pointing to the end of the transition period from planned to market economy).

The priorities and scope of university-industry collaboration differ significantly between developed and developing countries, as elaborated by Guimon [3] (see table 1). He claims that in developing countries, a major concern is the poor quality of education and the lack of financing available to universities. This often indicates insufficient capacity to join industry in innovation-related projects. Therefore, building effective university-industry linkages in this context takes time and sustained effort, because universities in developing countries generally have little experience in industry collaboration and limited managerial capacity in research. Also, existing collaboration tends to be more informal and to focus on the firms' recruitment of university graduates for staffing, internships, and consulting. Moreover, the research activity of universities is less likely to lead to spin-offs or patents which can be commercially exploited and hence in many developing countries university-industry collaboration is constrained by historically based cultural and institutional barriers, which take time to overcome.

Table 1 Priorities for university-industry partnerships at different stages of economic development along the three missions of universities

	Developed countries	Developing countries
Teaching University	• Private participation in graduate programs • Joint supervision of PhD students	• Curricula development to improve undergraduate and graduate studies • Student internships
Research University	Research consortia and long term research partnerships to conduct frontier research	• Building absorptive capacity to adopt and diffuse already existing technologies • Focus on appropriate technologies to respond to local needs
Entrepreneurial University	• Spin-off companies, patent licensing • Entrepreneurship education	• Business incubation services • Entrepreneurship education

Source: Adapted from Guimon [3]

3.2 The role of government in strengthening the university-industry alliance

Government institutions may influence the willingness of companies to collaborate with universities and the scope of such collaborations in a number of ways [3]:

- through a direct role in providing funds to universities and R&D projects, as well as through a regulatory role, influencing the rules of public universities and shaping the intellectual property rights regime;
- through providing the necessary infrastructure and intermediate organizations such as technology transfer offices, science parks, and business incubators;
- through soft measures, such as providing specific support services to companies/universities in the search for partners and promoting networking and raising awareness of the importance of collaboration.
- through designing R&D research grants, matching grants, and tax-incentives with a requisite of a consortium of companies and universities for project eligibility.
- through innovation vouchers as an instrument to promote collaboration, successfully tested in countries like the Netherlands, Ireland, and the UK: innovation vouchers are small lines of credit provided by governments to SMEs (small and medium enterprises) to purchase services from universities and public research centres, with the intent to introduce innovations in various business operations.

It is observable, however, that in many developing countries companies have shown little interest in requesting grants, because they either do not feel the need to collaborate with universities, or are not ready to match the funds with internal resources, or find the grant application process too complicated. Moreover, in developing economies universities often do not provide the incentives to align their research agendas with market demands, and thus cannot respond to the needs of local enterprises. Therefore, governments should find ways to stimulate university-industry collaboration through funding public universities based on indicators like numbers of students, PhD graduates, scientific publications etc. Also, governments can reform the reward systems for university professors and researchers by introducing new incentives to collaborate with industry. Finally, another important point is that any university regulations that might lead to excessive bureaucracy or unnecessary restrictions on how researchers interact with firms should be removed, whenever possible [3].

3.3 Major deficiencies in the Bulgarian educational system

According to statistical data from the Bulgarian National Statistical Institute (NSI) [5] as of December 2017 in the country functioned 1 834 independent kindergartens or with 60 less in comparison with the previous year. In these the number of children enrolled was 220.9 thousand children, of which 114.0 thousand or 51.6% were boys. In comparison with the previous year the number of children decreased by 1.6% (Figure 1).

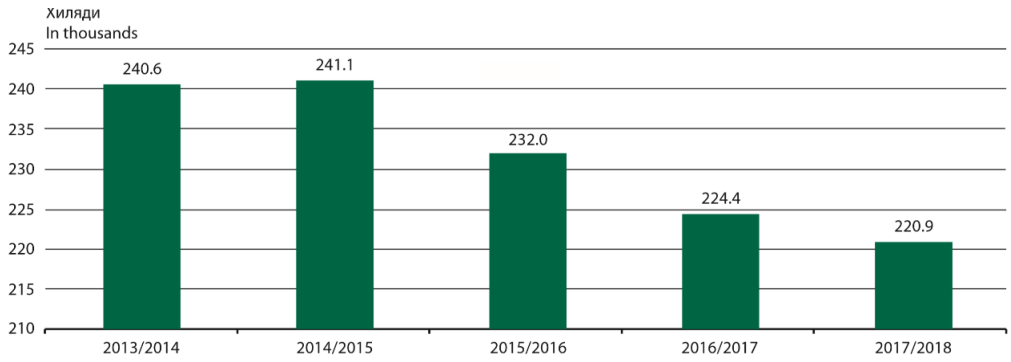

Figure 1 Children in kindergartens (Source: Bulgarian NSI [5])

The decrease in the number of children is an indication for the generally negative demographic tendency in Bulgaria after the beginning of the transition period in 1989. It further influences negatively the other educational levels. According to the Bulgarian NSI data as of 1.10.2017 there were classes in 1 969 general education schools. Out of them 137 were primary schools, 1 199 - basic schools, 58 - combined schools, 117 upper secondary and 458 - secondary schools. In comparison with the previous school year, because of closure or modification, the total number of general education schools decreased by 21. The students were 587.8 thousand, of which 90.2 thousand (or approximately 15%) were enrolled in schools in the rural areas. Another inefficiency of the system, as figure 2 shows, is that the majority of teachers employed in general education schools are at the age of 55 and

above (pre-retirement), which is due to the low salaries of the teachers and thus lack of interest in the profession. This consecutively leads to a general slowdown in the introduction of innovation methods and respectively to ineffective skills development and overall low quality of the secondary education in Bulgaria.

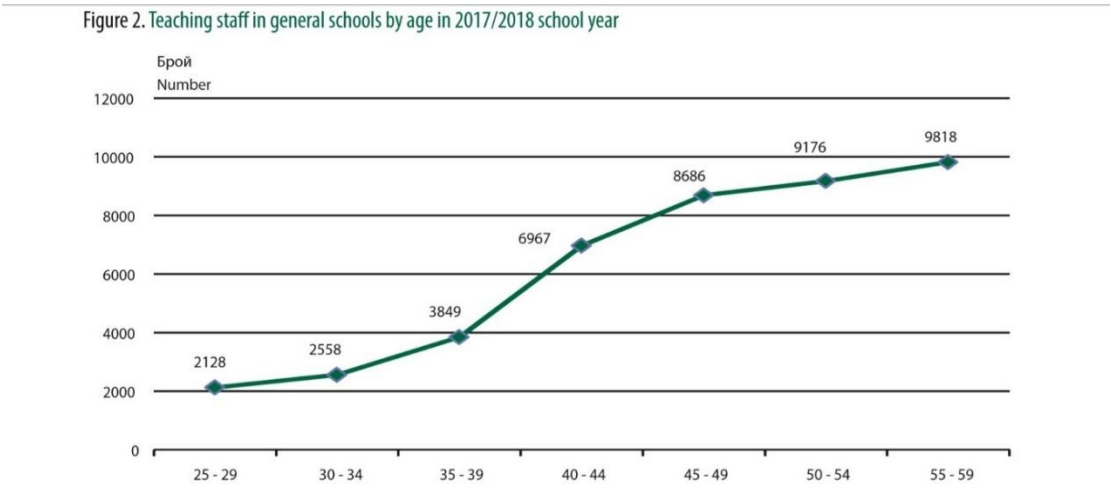

Figure 2 Teaching staff in general schools by age (2017/2018 school year, Source: Bulgarian NSI [5])

The statistical data for tertiary education reveals a similar negative tendency. In the academic 2017/2018 year, the total number of the students in Bulgaria enrolled in the four educational-qualification degrees (‘Professional bachelor’, ‘Bachelor’, ‘Master’ and ‘Doctor’) was 236.3 thousand, which is with 13.6 thousand, or 5.4% less compared to the previous academic year.

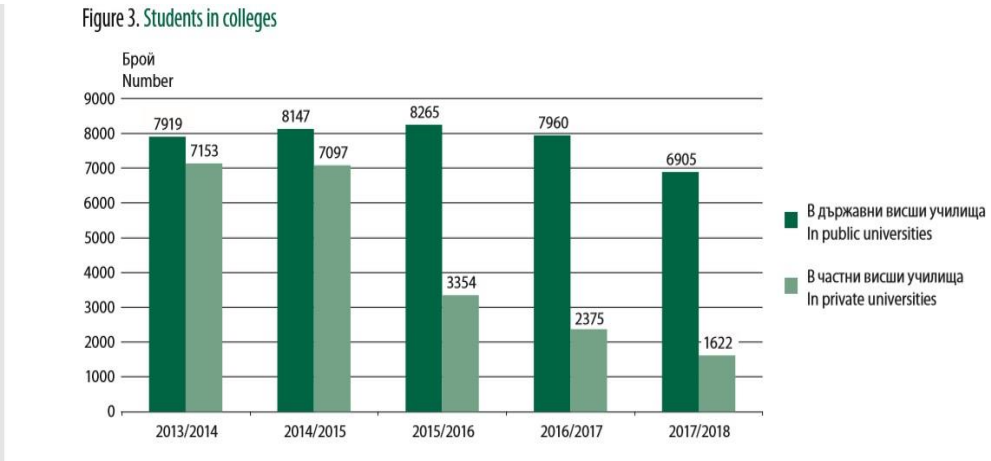

Figure 3 Students in colleges (Source: Bulgarian NSI [5])

Also, during the 2017/2018 academic year, for acquiring of the degree ‘Professional bachelor’, in colleges were enrolled 8 527 students. In comparison with the previous year their number decreased with 1 808 or with 17.5%. Out of the total number of the students in colleges, 1 622 or 19.0% were enrolled in private colleges (figure 3).

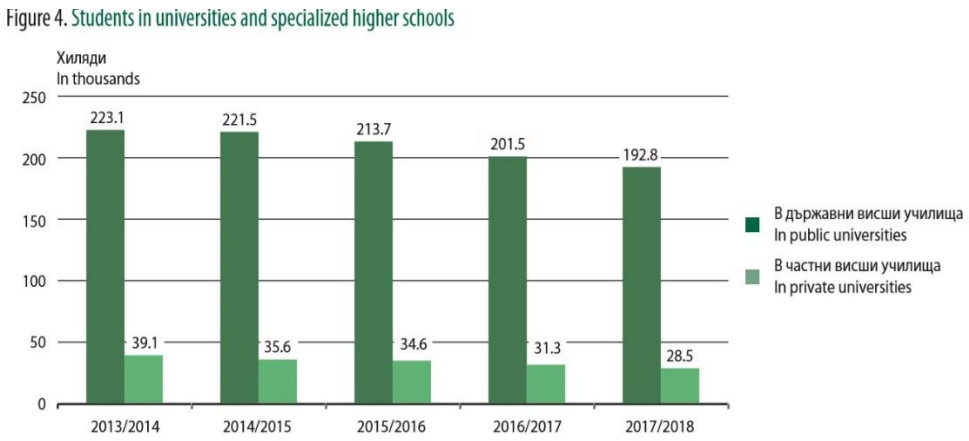

Figure 4 Students in universities and specialized higher schools (Source: Bulgarian NSI[5])

In 2017/2018 academic year, for acquiring educational-qualification degrees 'Bachelor' and 'Master' in universities and specialized higher schools were enrolled 221.2 thousand students and in comparison, with the previous year their number decreased by 11.6 thousand or by 5.0%. In private educational institutions were enrolled 28.5 thousand students or 12.9% of the total number enrolled in educational-qualification degrees 'Bachelor' and 'Master' (figure 4).

3. Results

The statistical data above confirms the existence of two major factors that have negative implications for the university-industry link in Bulgaria:

- the decreasing number of children and the low quality of education in general schools;
- the decreasing number of students enrolling into colleges and universities for the last 5 years and hence the deteriorating tertiary education.

The constantly decreasing number of human capital and its deteriorating quality of education and vocational training reduces significantly the possibilities of establishing a link between the universities and the business, which on its turn impacts negatively the overall economic performance of the country. In order to improve the university-industry alliance the government has to implement various instruments to encourage the population growth and to improve education at all levels (from primary to tertiary). Only thus it can be expected that a strong bond can be built between the academia and the private companies, which will boost economic growth and will ensure social progress.

These observations also show that the application of the Triple Helix model is especially valuable in reviving economies that require significant boost after some crisis period. The problem with these economies (such as the Bulgarian economy after the beginning of the transition in 1989) lies mainly in the inadequate development of the links between institutions, the centers for innovation development and research, and the entrepreneurial initiatives. The lack of development in each of these aspects and the impeded interrelation among them is a major cause for the difficulties in economic development and the social problems, that arise as a result of this, like: inequality, unemployment, and low-income levels.

4. Conclusions

This paper underlined the importance of the Triple Helix model in establishing the collaboration of government, educational institutions (the academia), and the industry (business). It also highlighted its function as a valuable instrument for the development of innovation and for solving many problematic aspects of economic development and social progress. The aim of the analysis was to apply the Triple Helix Model in the Bulgarian institutional environment by observing and critically discussing the problematic aspects, particularly those related to education. It was claimed that the major deficiencies in the university-industry collaboration in Bulgaria lie in the negative demographic tendencies and the related decrease in students enrolled in higher institutions, along with low quality of general education.

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CREATING OF THE GROWTH STRATEGY IN THE DIGITAL WORLD: VALUE CREATION IN THE INNOVATION COMPANIES

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Value creation in digital innovation companies can be viewed as a system of three interacting components. First, the domain choice, selecting where to compete. Second, the resource base in terms of individual and collective knowledge. These two components provide input in terms of the demand of customers and the capabilities in the resource base of the company, to the third component: the product or service delivery process (PSDP). The content of the PSDPs can vary according to the needs of the customer and aligned with the growth strategy of the company.
Methods:
We propose an approach to analyse the current situation with using intellectual capital in digital innovation companies for creating of the growth strategy. This methodology puts in evidence several examples of successful profiting from using of intellectual capital in the frame of current digital economics. The business models of pre-digital companies, based on promoting products, have also evolved. Their offer has gradually shifted towards services, to such an extent that what they are selling is not so much the product as the functions it serves.
Results:
The outcomes of the application can be used in business environment for the new high growing innovative companies working in digital business (IT-technologies, Big Data applications etc)
Conclusions:
In this paper, we synthesized the value creation perspective to study the value creation in digital application marketplaces. Based on an extensive research study of third-party developers we developed an empirically grounded understanding of value creation where we identified six value sources that are combined and exchanged to create values that can be realized by third-party developers.
Future studies could address several limitations in our work. It would be useful to compare our results with investigations of third-party developers from other countries. Another direction for future work would be to investigate value creation, and also potential value destruction, in digital application marketplaces from the perspective of users and owners of digital platforms.

Keywords
Digital Entrepreneurship, Intellectual Capital, Knowledge Assets, Value Creation

1. Introduction

Digital entrepreneurship as a relevant socio-economic and technological phenomenon, which can be considered as the joining of traditional entrepreneurship with an emphasis on leveraging new digital technologies in novel ways, such as social, mobile, analytics, cloud and cyber-solutions, all in order to shift the traditional way of creating and doing business in the digital era.

Digital Entrepreneurship can be defined as embracing "new ventures and the transformation of existing business by creating and using novel digital technologies. Digital Enterprises are characterised by a high intensity of utilisation of new digital technologies (particularly social, mobile, analytics and cloud solutions) to improve business operations, invent new (digital) business models, sharpen business intelligence, and engage with customers and stakeholders through new (digital) channels". However, it is important to stress that there is a difference between 'digital entrepreneurship' and 'digital business' in general and 'digital start-ups' and 'digital scale-ups', which we believe provides an additional perspective.

2. Assessment of Knowledge Capital and Intellectual Assets

The worth of knowledge assets, taking the difference between market and book values as a proxy, is hidden by current accounting and reporting practices. However, as evident from current valuations of many Net-based enterprises, one observes a significant widening gap between the values of enterprises stated in corporate balance sheets and investors' assessment of those values. The increasing proportion of intangible vis-à-vis tangible assets for most industrial sectors has been affirmed by various other observations [1], [2], [3]. In case of major corporations, often such high market valuations are attributed to brands. Recent business history has shown that huge investments in human capital and information technology are the key tools of value creation that often do not show up on company balance sheets as positive values themselves.

Measurement of institutional or organizational value in the current business environment using traditional accounting methods is increasingly inadequate and often irrelevant to real value in today's economy. For instance, while traditional accounting practices often treat brand as depreciable entity over time, in today's economy, intangible assets like brands and trademarks often increase in value over time, often longer than the time periods accounted for their depreciation. Even, specific kinds of valuations of intellectual capital, such as patents, copyrights and trademarks are not valued according to their potential value in use, but recorded at registration cost. Similarly, the distinction between assets and expenses is made arbitrarily on many balance sheets: an advertising campaign could be recorded in either column as evident from a case such as that of AOL. The traditional balance sheet, a legacy of last five centuries of accounting practices, provides a picture of *historic* costs, assuming that the cost of purchase reflects the actual value of the asset. However, it does not account for the hidden value inherent in people's skill, expertise and learning capabilities, the value in the network of relationships among individuals and organizations or the structural aspects relevant to servicing the customers. These hidden values or intangible assets assume increasingly important role in an economy that is characterized by a transition from 'programmed' best practices to 'paradigm shifts' that characterize the new business world of 're-everything' [4]. Such factors are assuming greater importance in assessment of the potential for future growth of an enterprise or a national economy.

This issue is compounded by an apparent paradox: the more a company invests in its future, the lesser is its book value [although the recent astronomical caps for various Net-related stocks suggest increasing realization about intangible assets]. Extrapolating the case of such companies to the organizations within a national economy, one may understand the implications for accounting for intangible assets that do not show up in accounting reports, but may underpin their future success or failure.

Valuation from the perspective of intellectual capital and knowledge assets takes into consideration not only financial factors, but also human and structural factors [3]. Stewart defines intellectual capital as the intellectual material that has been formalized, captured, and leveraged to create wealth by producing a higher-valued asset. Intellectual capital is defined as encompassing: i) human capital; ii) structural capital; and iii) relational capital. These aspects of intellectual capital include such factors as strong business relationships within networked partnerships, enduring customer loyalty, and employee knowledge and competencies. The compelling reasons for valuation and measurement of intellectual capital and knowledge assets include understanding where value lies in the company and the sectors of the national economy and for developing metrics for assessing success and growth of companies and economies.

3. Measuring Knowledge Assets and Intellectual Capital

Managers of enterprises and national economies are trying to find reliable ways for measuring knowledge assets to understand how they relate to future performance. The expectation from finding reliable measures of knowledge assets is that such measures can help managers to better manage the intangible resources that increasingly determine the success of the enterprises and economies.

The terms knowledge capital and intellectual capital are used synonymously in this article. The subsequent discussion reviews the case of an Asian nation state that utilized one of the more popular methods for assessment of its national intellectual capital. Concluding discussion will highlight the existing caveats in the adopted methodology and underscore the important issues that need to be addressed in future research and practice.

4. The Innovation Capability Model

As was stated [5] that Innovation Capability Model assumes that company's performance is based on the results of the innovation which, in turn, is primarily dependent of the innovation sources. Innovation capability itself, then, is not a separately identifiable construct. A holistic model of innovation capability will thus attract debate about categorization of pillars and elements, but it is a necessary step in order to facilitate analysis and construction of an innovation framework. The pillars and elements have been built up from the literature on innovation management as well as best practice and specific studies of innovative firms.

The following pillars are proposed to exist within innovative companies. They are strategy, innovation sources, innovation capacity, innovation process and innovation results. The innovation capability will lead to continuous products, process and system innovation. The stronger innovation capability possessed by a company, the more

effective will be its performance and value creation. The core pillars of innovation capability, as well as their major elements. Are discussed in detail in the next sections:

4.1 Strategy

The link between strategy and innovation is important to effective innovation management. This is a critical step in institutionalizing innovation, creating a vision, a target which if achieved will create products that outperform and provide a distinct market position. The success of companies breaking the rules of their industries through innovation and become a dominant player has been well-documented [6], [7], [8].

4.2 Innovation sources

Competitive pressure and rapid growth of ICT have forced companies to review the sources of their innovation performance and value creation dynamics. The concept of knowledge has emerged a strategically significant resource for the firm [9], [10] and has been asserted to play a significant role in innovation process.

4.3 Innovation capacity

In this model, innovation resources nurture innovation capability. The innovation capability enables integration and transformation of resources to develop potential innovation that can be transferred into companies` processes through the leverage of their knowledge base [11]. The cross-functional integration and co-operation of organizational capabilities are at basis of "innovation capacity". In fact, the "innovation capacity" can be interpreted as the organizational ability to mould, integrate and manage multiple resources and capabilities of the firm to successfully stimulate innovation.

4.4 Innovation processes

Traditionally, process research addresses the nature of the innovation process, how and why innovations emerge and grow. In this model, process has come to be conceived as a temporal, path-dependent phenomenon [12], [13], [14] that is a collection of tasks or activities and an integration and exploitation of organizational capabilities which together transform inputs into outputs. Successful innovation requires an optimal overall formal business structure [15]. The nature of the innovation process has been shown to be affected by a range of factors such as organizational structure [16], [17], [18], environmental factors [19], technology management. The management of technology is critical for all kinds of organizations. Innovative companies are able to effectively link their core technology strategies with the innovation strategy and business strategy.

4.5 Innovation outputs and company's value creation

Innovation makes to competitive advantage [19]. This output has generally been construed in terms of financial, market or organizational performance. Output performance research focuses intently on the role of novelty or newness as a factor of successes, although results are not completely shared [20], [19]. According to a value-based approach [21], superior innovation performance mean major value created for company's key stakeholders.

5. *Value Creation in the Digital World*

The significant developments in digital network and communication technologies has led to the emergence of digital business [22]. Organizations then started to scramble to develop new business strategies that align with their business objectives. But continued advancements in technology have enabled new dynamic organizational capabilities as well as transformed social structures and relationships [22]. For this reason, it has been suggested that it is becoming increasingly difficult to separate digital products from IT infrastructure. New forms of organizing emerge due to the confluence between IT and organizational capabilities resulting in new affordances for creating value in organizations [23], [22] argued that this perceived inseparability compels rethinking the traditional business-IT strategy alignment view and instead move towards their fusion in digital business strategies.

They defined digital business strategy as "organizational strategy formulated and executed by leveraging digital resources to create differential value". One of the four pillars of their conceptualization of digital business strategy is the sources of business value creation and capture. In digital business, organizations continue to leverage IT infrastructures to create new sources of value creation and sustainable competitive advantage [24], [25]. Information is one key source for value creation. There is established recognition of increased value from information by using IT [22], [24]. IT has enabled significant transformation in the ways information is created, exchanged, shared, remixed, and redistributed which in turn caused dramatic power shifts in market channels and disruption of traditional sources of economic profits. These transformations have created fundamentally new sources of value. This can be seen in digitization processes through which new combinations of resources result in novel product and service innovations. The encoding of analog information into digital format like in many contemporary newspapers that are shifting from physical creation and distribution of content into the digital arena is an example of the creation of new innovative digital sources of value. The shift into digitized information at Newsweek magazine, for instance, shows how the magazine started to explore new sources of value creation by balancing between subscription and advertising [22].

Digital mobile platforms like Apple's iOS, Google's Android, and Amazon's Kindle are important examples of how the digitization of products and services has created new ecosystems of value that redefined the entrainment,

music, and book publishing industries. In this respect, it was [22] discussed several new digital strategy frameworks to capture new sources of value creation in such marketplaces such as generativity, heterogeneity, creating digital product platforms and meaning-making capabilities. Besides information-based value creation, there is also the integration of IT in physical artifacts. In the article [22] discussed another dimension of value creation with IT. They explained that the value of IT lies in its integration with and expansion towards third-party components. They argued that the increasing embedding of digital components into physical products has created novel layered modular architectures.

An example of this was reported in [26] where they discussed the integration of service-based modularity into component-based modularity within the car infotainment industry. This kind of integration creates new forms of digital materiality which leads to the "emergence of digital service architecture for previously non-digital products and services" [22]. Clearly, such innovative architectures have the potential to enable novel sources for value creation and competitive advantage for both organizations and developers.

6. Conclusions

In this paper, we synthesized the value creation perspective ([27]) and digital platforms perspective to study the value creation in digital application marketplaces. Based on an extensive research study of third-party developers we developed an empirically grounded understanding of value creation where we identified six value sources that are combined and exchanged to create values that can be realized by third-party developers.

Future studies could address several limitations in our work. It would be useful to compare our results with investigations of third-party developers from other countries. Another direction for future work would be to investigate value creation, and also potential value destruction, in digital application marketplaces from the perspective of users and owners of digital platforms.

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THE ROLE OF EDUCATION IN THE EMPLOYABILITY OF YOUNG IN TERMS OF SKILLS DEVELOPMENT

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Abstract
The Degrease of young unemployment is in the central of interesting of European Union (EU) policies, skills have become the global currency of 21st century economies, but skills are acquired at all stages of formal education and training. The role of educational to prepare young to enter to the labour market and throughout their working lives is in the central point of global and (EU) policies. Under these challenges, the research of relation the employment rates with indicators of skills is essential. This research based on quantitative analysis of databases of EU focus to provide results that combine unemployment and educational actions for each country. The results review educational policies implemented successfully to countries with high level of youth employment and examples of educational initiate practices. At all, this paper not only concluding directions for the structure of EU educational policies followed the need of young workers with development skills, but also provide to educational community suggestions for innovative practices.

Keywords
Educational actions and policies, employment rate, young, skills,

1. Introduction

European Union faces an increasing rate of unemployment in the terms the global financial and economic crisis. However, the labor market shows that there are difficulties to find the employees with the right job skills requirement, especially in the field of Science, Technology, Engineering and Mathematics (STEM) [1], as result of the rabidly rate of increasing new technologies. The development of skills is one of the priorities of the European Commission's strategy for educational systems and the young unemployment is an inhibitor for the sustainable recovery and growth. Education is of strategic importance for personal, social and professional

development, as well as for lifelong employability for young. It is closely linked on the new skills agenda for Europe [2] with expected medium-term effect of providing employment opportunities all young people. The research of the relations between indicators of skills in combination with young unemployment rates focus on highlight the role of education. Under this framework, this paper provide as proposals guidelines for quality strategic plans to educational systems and educational practices, through European projects, that will support the safe transition of young people to workplaces and the increasing the employability of young with right skills for right jobs.

2. Research framework

A review to policy makers' reports highlights the importance of the development of transferable skills for determination the competitiveness and the innovation in social communities. Transversal Skills (such as critical thinking, creativity, initiative, problem solving, risk assessment, decision taking, communication and constructive management of feelings) considered as skills that can be used in a wide variety of situations and work settings and are essential for the transition of young to workplaces. One of the series of recurrent themes that are important for education policy makers, practitioners, researchers, and the public and included to Indicators of Education Systems (INES) of Organization for Economic and Co-Operation and Development (OECD) [4] is the output of educational institutions and the impact of learning for the participation in the labour market and the social outcomes. Researches of the relations the education and the labour market includes many views such as years of schooling, educational level attained, attainment of a particular credential, educational system, investments in education and curriculum type [5].

The percentage of young not in education, employment or training (NEET) has increased by 2010. Researchers about the causes and the impact is a starting point to highlight the critical role to educate young people to be secure socially and not just being the a means of safeguarding employment [6], [7]. Nowadays upcoming occupations to the new digital age increased rabidly, while the labour roles currently affected by technological depreciation, as there is major shift in the division of labour between people, machines and algorithms. The existing evidence underlining the importance of focusing on the quality of education and improving the real learning outcomes and skills proficiency for all. Empirical findings in this area show the central importance of secondary education interventions to cognitive, to non-cognitive skills and mostly to transversal skills underline the importance of improving the learning outcomes of youth and providing support to youth during the critical transition from school to first-time employment [8].

3. Methodology

The hypotheses of this research is that educational actions focus on skills development have positive impact to the employability of young for EU countries. Eurostat by European Commission [9] provide the data for unemployment/employment rates for all categories of young person. The variable of employment rates of young aged 20 to 29 (based on the EU Labour Force Survey, it is calculated by dividing the number of persons in employment and by the total population of the same age group) considered for comparison with variables related to educational actions for development skills. The European Skills Index (ESI) of European Center for the Development of Vocational Training (Cedefop) [10] presents the performance of European Union (EU) for skills system. It includes three pillars; skills development, activation, matching, and each of which measures a different aspect of skills system.

This research considered the variables (with the latest updated data for the year 2018) related to skills activation and development (matrix 1 in appendix), because they reflect the actions in each country for basic education and other forms of education and training (lifelong learning activities). Except of quantitative statistical analysis in the new databases with the considered variables a linear regression model, as export of statistical progression with SPSS software, provides the relationship of employment rate and development and activation skills. Finally, the results are completed by reports of best practices that implemented in countries with low index of unemployment in order to provide replies in the ways that could filled the gap between learning in high school and jobs.

3. Statistical analysis and results

3.1 Overview of unemployment rates in EU

For unemployment of young person EU we compare the total unemployment as percentage of active population with young aged less than 25 years old and them who are recent graduate the young, (figure 1 in appendix, matrix 1 in appendix presents analytically the percentages of all categories). EU has a significant heterogeneity in employment rate for young (aged 20-29) and in total across European countries (figure 2 in appendix). The last 10 years countries such as Greece, Spain, and Italy has the highest percentage in unemployment in all grouped of ages (figure 3 in appendix), in agreement with long-term unemployment (figure 4 in appendix*)*.

It is assumed [11], [12] that the causes of unemployment are related with the dynamic of economy in each country. Low-income and middle-income countries face employment issues that go beyond unemployment. In this empirical research, we focus on the relationship between education and employment. At global scale, the

educational attainment has positive relation with employment rate in all ages. The difference (figure 5 in appendix) in percentage of employment rate between tertiary educational level (defined as the total of those who have a short-cycle tertiary, bachelor's or equivalent, master's or equivalent and doctoral or equivalent [13]) and below upper secondary fr ages 25-64 years old identify that the investment in high level of qualifications increase the possibilities of a finding a job. The differences in global scale are also significant between tertiary educational level and upper secondary or post-secondary non-tertiary (figure 6 in appendix). The negatively association between unemployment and the level of qualification of educational level also applies in EU (figure 7 in appendix). This suggests that the quality level of completed education in development skills force the employment rates in all countries.

3.2 Comparison indicators of skills with employment rates

Countries with high level of employment rate such as Netherlands, Austria, United Kingdom, Germany and Sweden support the skills' development (figure 1) and activation (figure 2), through policies or educational national programs. Low percentage of skills development and activation imply low percentage of young employment rate in Countries Greece, Italy and Spain. In other worlds, the same relation highlighted with the comparison of unemployment rate and skills development (figure 8 in appendix) and skills activation (figure 9 in appendix).

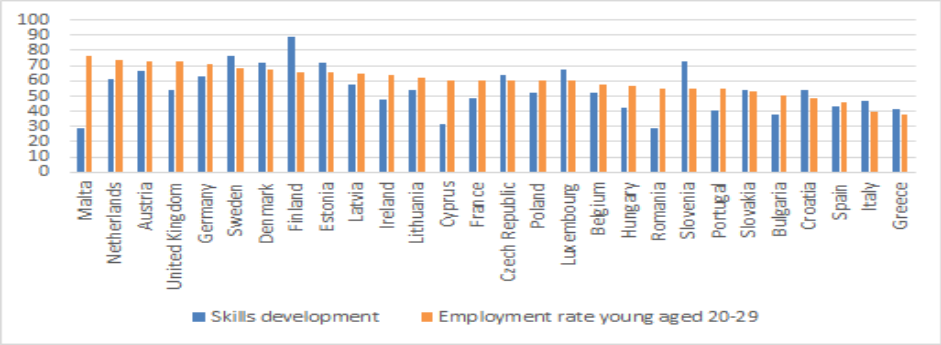

Figure 1 Level of young employment rate in comparison with the skills' development

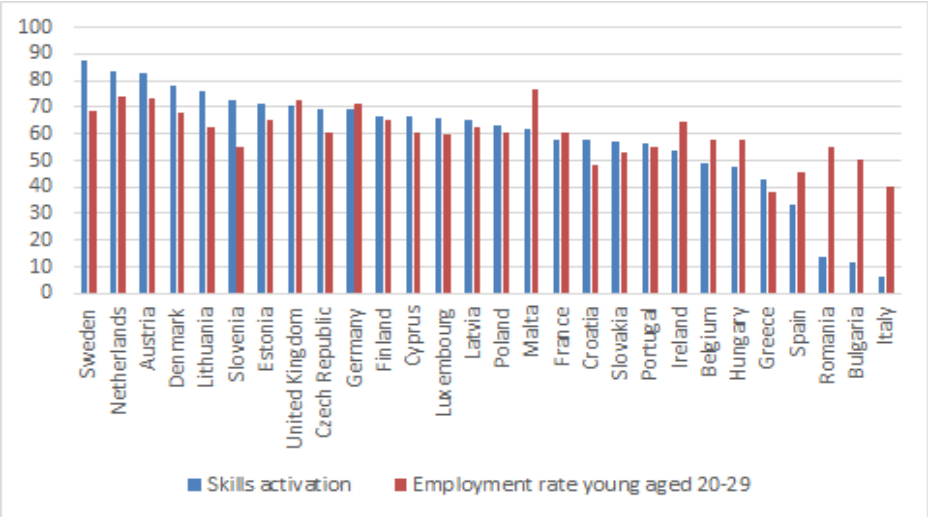

Figure 2 Level of young employment rate in comparison with the skills activation

Countries with highest level of young employment rates present to activate all parameters in development the abilities and skills of young people to acquire knowledge, skills and competences that will lead to better employment prospects to be able to respond to labor market requirements (figure 3). In opposite, countries with lowest level in employment rates don't activate in high percentage the indicators related to skills development (figure 4).

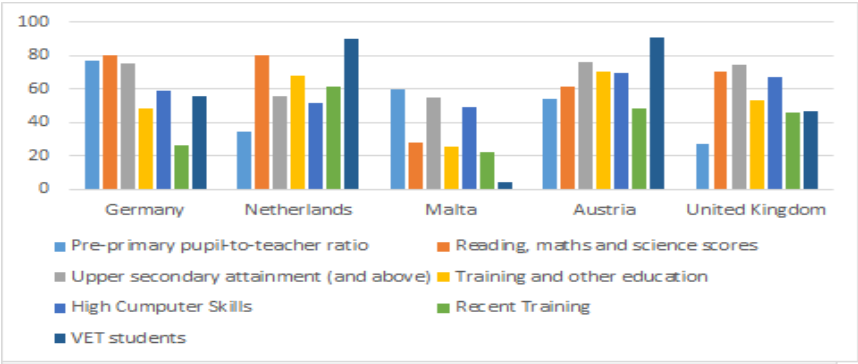

Figure 3 Educational factors for activation skills to countries with highest level in young employability

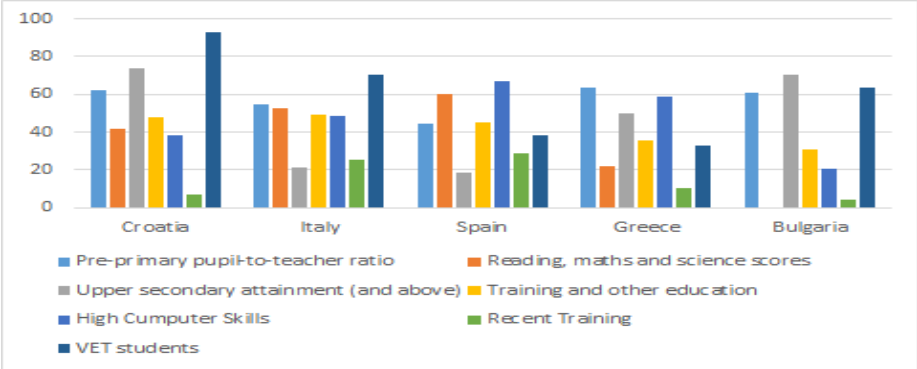

Figure 4 Educational factors for activation skills to countries with highest level in young employability

The causes of low or high level of young unemployment need to take under consideration all the factors included in the structures of labour markets. The indicators of transition to work and participation to labor presented in low percentages to countries with high level of unemployment (figure 10 in appendix). The country sizes, the minimum wages, the over qualification rate, the mismatching qualifications (figure 11 in appendix) or part timers young employment (figure 12 in appendix) may occur high level of employment affect the young employability. Characteristic example is Malta that does not present high percentage in development and activation skills, but present high level in young employability through to high percentage of the factors referred above. Additionally, needed research in relations to skills demand with young employment rate for each country. However, it is clear by the empirical results of this research for supply skills that required by schools to prepare young people for the future of jobs through development skills.

3.3 Linear Regression Model

There is a significant correlation between young employment rate and skills activation (matrix 4 in appendix), rather than between young employment rate and skills development. The second case refers to a further multivariate test. The least squares method provides the predictive model of increasing the employability of young people by activating skills is Y=35,689+0,312X, the independent variable (skills activation) (matrix 5 in appendix) explain 51, 3% of volatility of depended variable (employment rate) (matrix 6 in appendix). This has resulted by rejected the checking the case: that there is not significant statistic model for the variables: young unemployment rate (Y) –skills activation (X).

3.4 Results

Work-based learning for cooperation education with workplaces is a means to ensure that pupils of all ages will have the knowledge, skills and competences that a future labor market requires [14], [15]. In countries with high level of employability in young included apprenticeship in secondary educational level with different forms [16] (matrix 2 in appendix). Education has a main role to encourage young to the development the transversal skills from schools to workplaces. The cooperation between education and *employers with implementation all forms of worked based learning (apprenticeship, jobshadowing, STEM careers event, short or long training to*

companies and industries), should ensure that the learning environment includes the world of work [17],[18],[19].

In particular, for the apprenticeship (as basic form) of worked based learning in most countries where system is more developed, young people have better labor market outcomes [20], [21]. Additionally, dual system by alternating school and workplace offer many advantages of improving early labor market transitions [22],[23],[24] with excepted outcomes to increase employability of young, as provided by measured in a variety of ways to countries with low unemployment rate.

Policies has an important role for the structure of educational system and curriculum, but also all stakeholders has a critical role to activate innovative approaches in schools community. There are many European initiates to increase the school adequacy to develop basic skills needed to enter in the labor market (analytical ability, scientific thinking and problem solving, creativity etc). The European project Development and Evaluating Skills for Creativity and Innovation [25] has successfully improve the European methodological standards of alternating training in secondary technical and professional School system [26]. The project includes manuals/guidelines for the presentation of methodologies, operational tools and suggestions aimed to support students and teachers, during the alternating training experience, in technological study areas. Educational approach to business, economics, and Entrepreneurship for implementation to school community provided by European Project Play4Guidance [27], that introduce an innovative Business Game with the aim to train and guide students and young unemployed on entrepreneurial, transversal and mathematical skills. One of the basic contexts of this project is the self-evaluation tool that could be directly used as a tool for evaluation and guidance target groups and stakeholders (centres for guidance, employment centres and personnel of companies, etc.). The self-evaluation tool provides feedback on: (1) how the users (teams and/or single players) have managed their company, (2) several types of managing such as managing investments, managing workers and training, managing production, managing sales, managing supplies, etc. and (3) skills and/or competences that users should strengthen [28]

4. Conclusions

The empirical statistical analysis of this research provides a connection between educational actions in terms of skills development and activation. Although young unemployment based on countries' social and economic characteristics the stakeholders have to take under consideration that work based learning programs reply to the needs of labor markets higher levels of employment rates. Moreover, there is need for research in national and global scale for assessment relations between the employability and educational actions for development transversal skills. According to this framework, educational policies need the support of universities for evaluation the connection between workplaces and education for development skills through doctoral thesis and many differently validated research data[12]

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Appendix

Matrix 1 Subcategories of indicator of skill development

Skills Development	
Basic education in Skills Development	Training and other education in Skills Development
Pre-primary pupil-to-teacher ratio	Recent training
Upper secondary attainment (and above)	VET students
Reading, maths and science scores	High computer skills

Matrix 2 Percentage of young unemployment in EU from 2007 until 2018

EU (28 conutries)	Unemployment rate recent graduate	Unemployment rate less than 25 years	Total
2007	19,1	15,8	7,2
2008	18	15,9	7
2009	21,7	20,3	9
2010	22,6	21,4	9,6
2011	22,9	21,8	9,7
2012	24,1	23,3	10,5
2013	24,6	23,8	10,9
2014	24	22,2	10,2
2015	23,1	20,3	9,4
2016	21,6	18,7	8,6
2017	19,8	16,8	7,6
2018	18,8	15,2	6,8

Matrix 3 structure of apprenticeship in countries with high level young employability

Switzerland, Germany	Long term and well-developed apprenticeship systems representing the majority of youth
Austria, Denmark, Norway and the Netherlands	Apprenticeship systems accounting for about a quarter and a half of all youth
France, Sweden	Unpaid switching arrangements represent a fairly high percentage of young people

Matrix 4 correlations of i) employment rate and skills activation ii) employment rate and skills development

		Emloyment rate	Skills activation	Skills development
Pearson Correlation	Emloyment rate	1,000	,723	,389
	Skills activation	,723	1,000	,325
	Skills development	,389	,325	1,000
Sig. (1-tailed)	Emloyment rate	.	,000	,020
	Skills activation	,000	.	,046
	Skills development	,020	,046	.

Matrix 5 Coefficients for predicted model with independed variable as skills activation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	35,689	5,443		6,556	,000
	Skills activation	,312	,066	,667	4,695	,000
	Skills development	,113	,093	,172	1,209	,238

Matrix 5 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	,741[a]	,549	,513	6,82894	,549	15,207

Matrix 6 ANOVA Table for all information of regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1418,365	2	709,182	15,207	,000[b]
	Residual	1165,862	25	46,634		
	Total	2584,227	27			

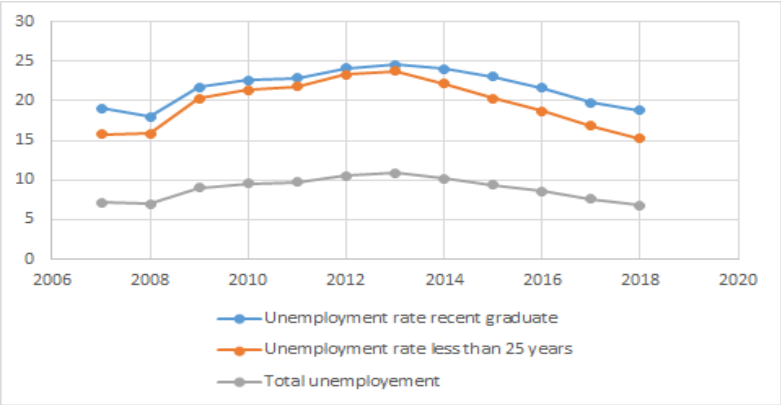

Figure 1 Graphical representation unemployment rates in EU

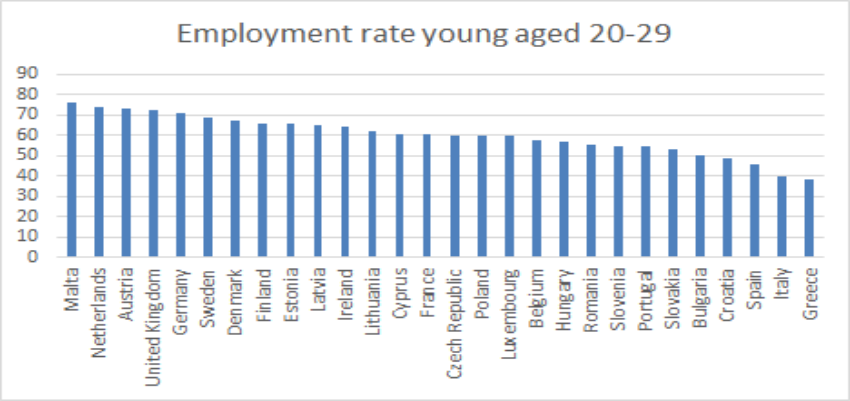

Figure 2 Graphs Young employment rates in 2018 for EU countries

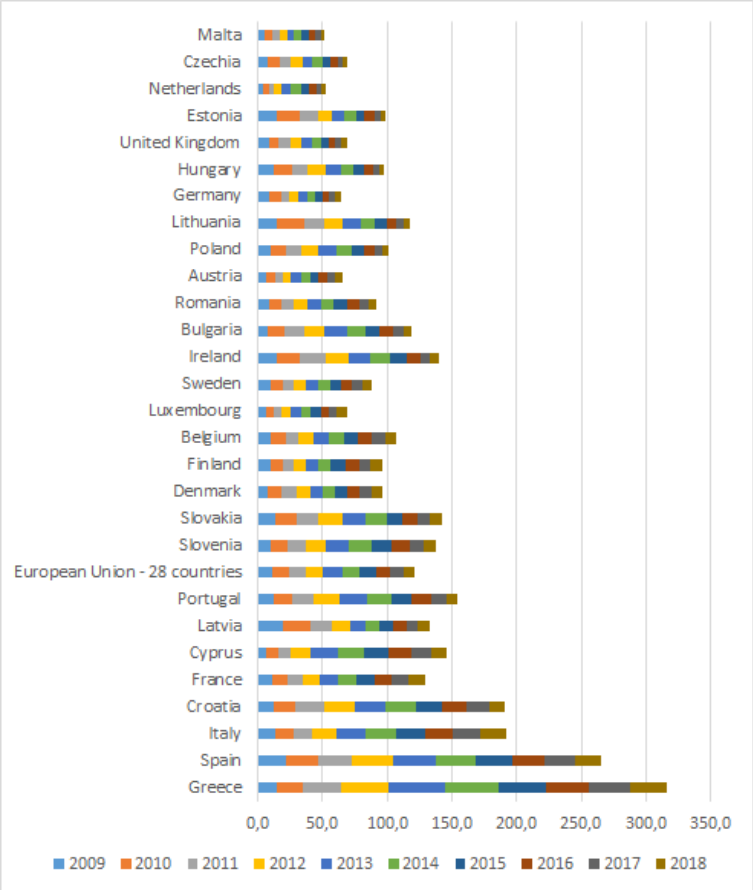

Figure 3 Unemployment rates for EU countries from 2009 to 2018

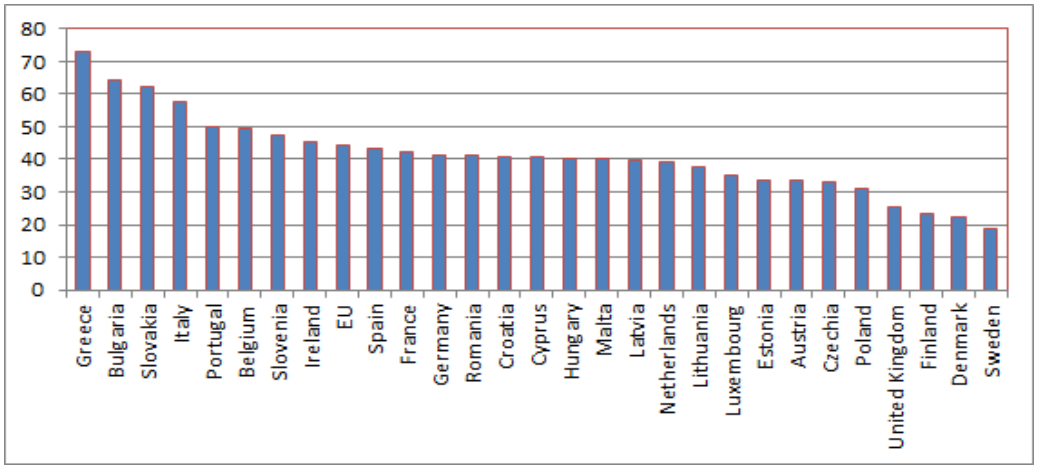

Figure 4 Long term unemployment in EU countries

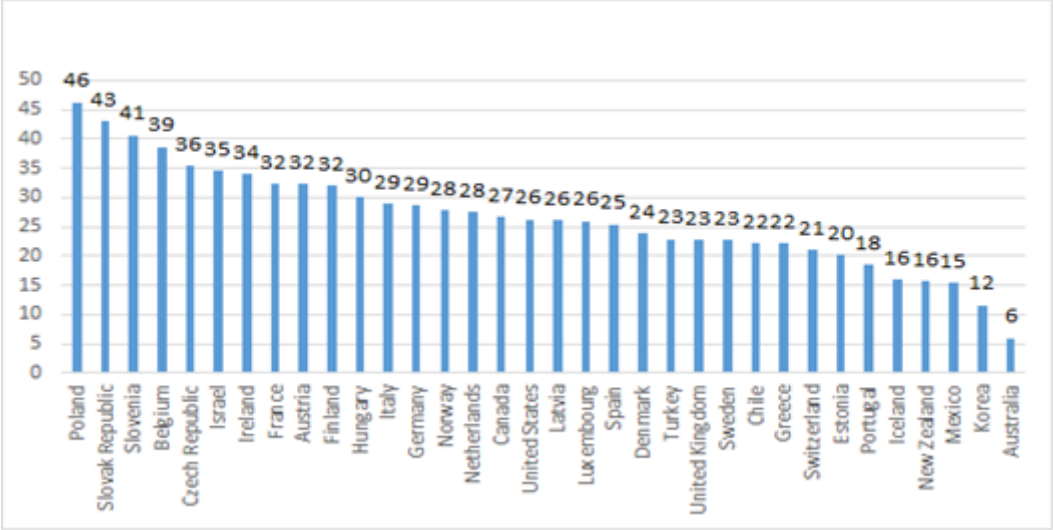

Figure 5 Difference in employment rate between tertiary educational level and upper secondary, 2017

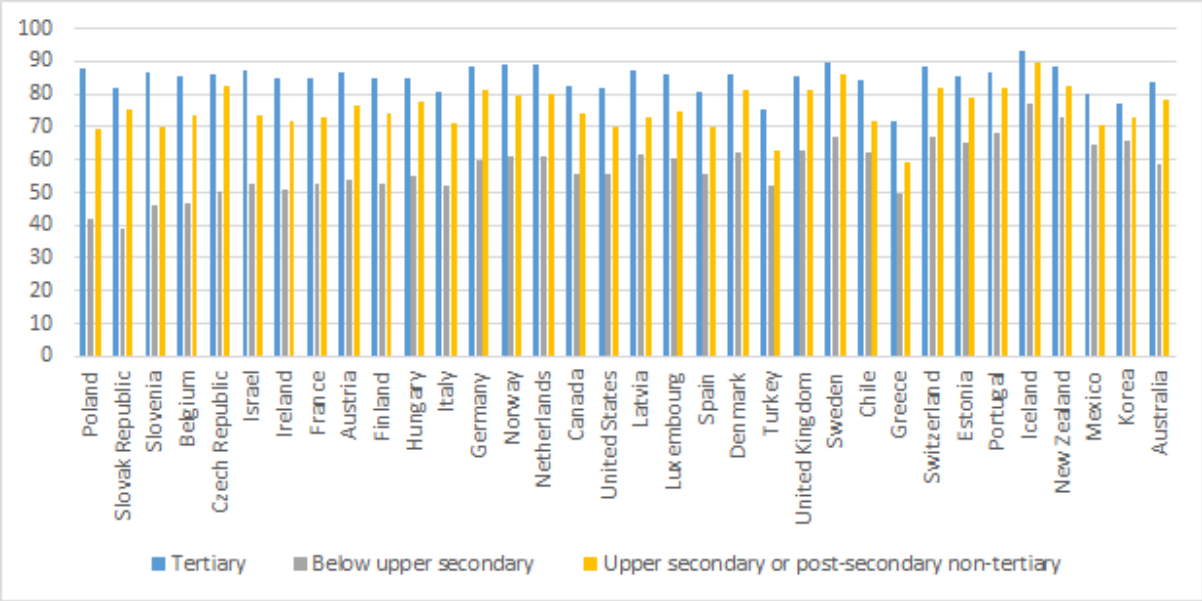

Figure 6 Employment rate in global scale by educational level

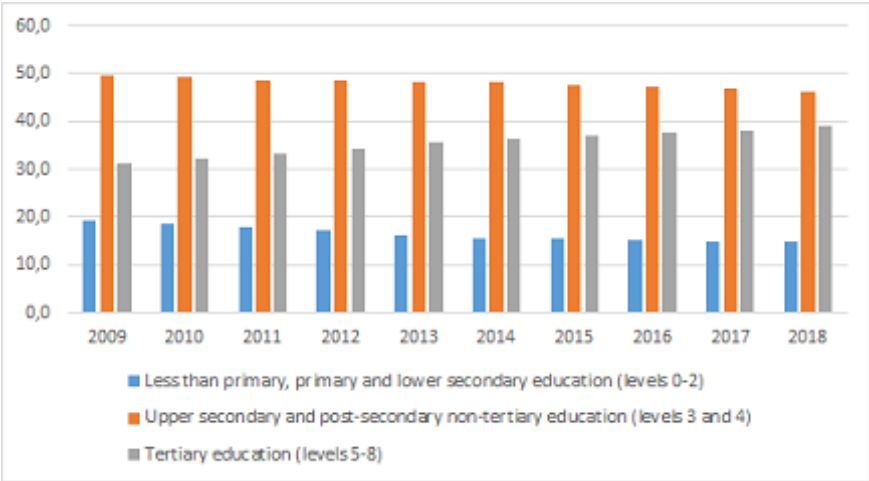

Figure 7 Employment by educational level in EU

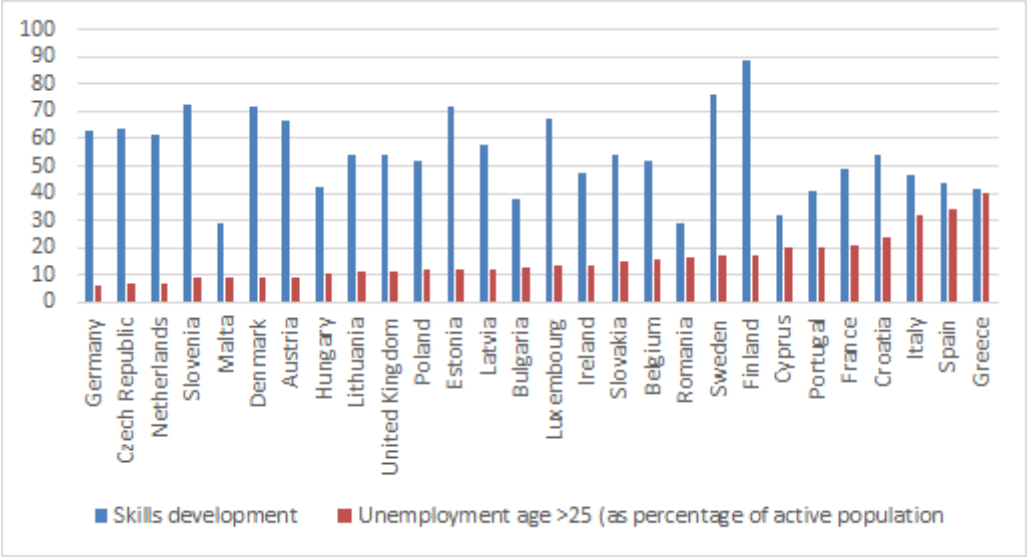

Figure 8 Comparison the indicator of skills development with young unemployment rate in EU, 2018

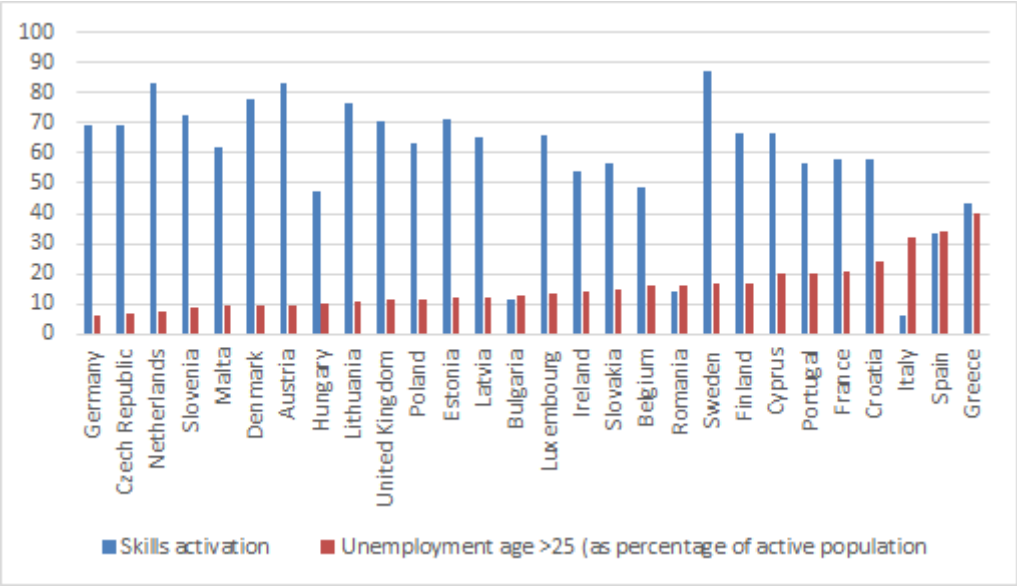

Figure 9 Comparison the indicator of activation skills with young unemployment rate in EU, 2018

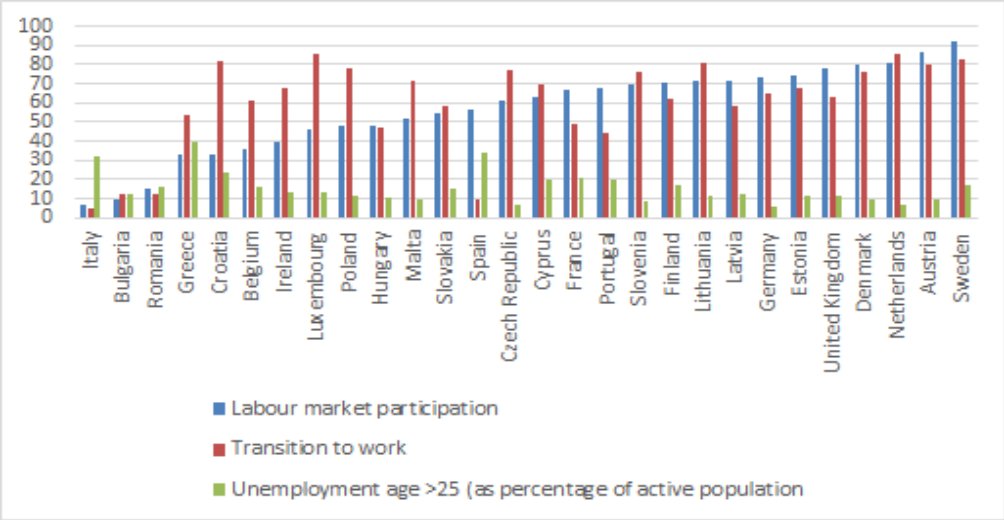

Figure 10 Young unemployment rates in comparison by rates of participation in labor market and transition to work

Figure 11 factors of wages, the over qualification rate, the mismatching qualifications in EU countries (part timers young employment (figure 12 in appendix) may occur high level of employment affect the young employability

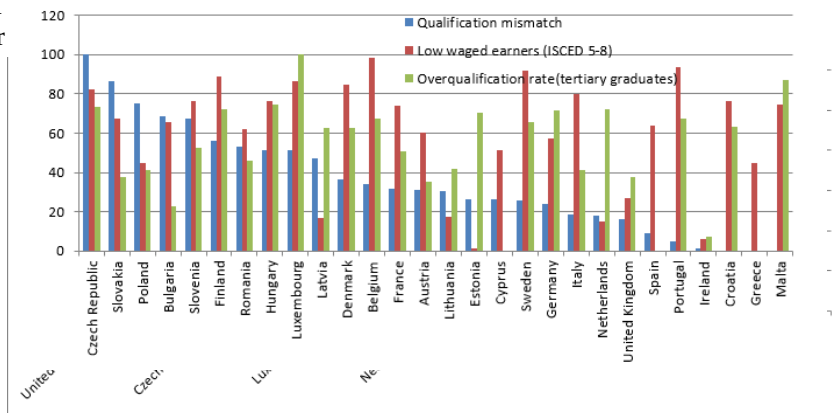

Figure 12 part timers young employment in comparison with long term unemployment in EU

INDUSTRY - UNIVERSITY PARTNERSHIPS IN THE REPUBLIC OF NORTH MACEDONIA

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Abstract
Partnerships between university and industry are increasingly a significant part of achieving maximum productivity and efficiency of the national system. Such collaborations can enhance innovation through knowledge exchange and simulation of technology development. In the Republic of North Macedonia, there are poor linkages between the university and industry, as well as the non-existence of creative intermediaries and support institutions are particularly critical. The government is not a completely developed facilitator, as a consequence of that fact, alternative sources should be established for allowing progress and improvement in the educational system in the country. The paper presents the establishment of Project Hub on the Faculty of Mechanical Engineering – Skopje, where the main goal is to fulfill all the gaps and improve the connection between industry and university partnerships. Project Hub represents the connection between the students, indusrty and university, and the great influence on everything individually. The link between them offers the students a possibility to gain hands-on experience and provides more employment opportunities for university graduates. Also, it provides access to students for internships and hiring and more solutions to the specific problems that the companies are facing.

Keywords
Educational system in the Republic of North Macedonia, Engineering projects, Faculty of Mechanical Engineering, Industry-university partnerships, Higher education, Knowledge and technology exchange, Project Hub, Students, Systematic review

1. Introduction

Universities-industry collaboration refers to the interaction between any parts of the higher educational system and industry aiming mainly to encourage knowledge and technology exchange [1]. Funding provided by industry for any number of programs can play a major factor in the overall success of the universities. Partnering can also provide new opportunities for universities to reconfigure the way instruction gets funded, developed, marketed, delivered, and supported [2]. There are lot of benefits of the partnerships for both universities and industry. This kind of partnerships are critical for skills development, adoption of knowledge as innovation and technology transfer, as well as promotion of entrepreneurship.

With regards to universities, pressures have included the growth in new knowledge and the challenge of rising costs and funding problems, which have exerted enormous resource burdens on universities to seek relationships with firms to enable them to remain at the leading edge in all subject area [3]. The main advantage for the universities of these kind of partnerships is that they provide financial support for educational, project work and research purpose; expand the experience of students and faculty staff; discover new and innovative solutions for many problems; increase the practical experience of students; and offer more employment opportunities. The partnerships can also enable graduates to pursue technical careers and to improve and adapt their skills to accommodate rapid technological changes, due to the fact that traditional learning only from provided books on the faculty is not sufficient, cannot prepare graduates on a higher level and make them ready to follow all the changes in the world trends.

For industry, such partnerships provide access to expertise they did not have; aid in the renewal and expansion of technology; improve access to students as potential employees; expand precompetitive research; and leverage internal research capabilities [4]. Likewise, for industry these partnerships improve access to students as potential employees and expand the research on various topics important for the industry. That increases the possibility of finding new possible solutions for many problems and make progress in expansion and promotion of new technology.

The evidence of developed countries shows by generating knowledge and using this knowledge in production to achieve efficiency in economy and innovation, in this way they gain a significant competitive advantage in world markets. University-industry Collaborations are one of the ways to obtain a competitive advantage [5]. Nowadays, in North Macedonia the interaction between the industry and universities is constantly decreasing and has been an important issue for some period. In the more developed countries, this kind of collaboration already exists, therefore there is an evidence of the many achievements and efficiency it can bring.

This paper presents the desire for improvements and fulfilling all the gaps on every level with the formation of Project Hub and establishing the connection between industry and faculty. The rest of the paper is structured as follows. The next section provides the challenges of engineering education system in the Republic of North Macedonia. The third section discusses about the goals, objectives and activities of Project Hub. The fourth section presents the success stories of Project Hub. Conclusion is presented in the last section.

2. Challenges of engineering education system in the Republic of North Macedonia

The educational system in the Republic of North Macedonia has many opportunities for further enhancements to fully reflect the needs of the society for educational, scientific and permanent role of the education and science for the economic, social, technological and cultural development of the society. Despite the fact that the Government of the Republic of North Macedonia is making continuing efforts for improving the quality of education through curriculum modernisation, continuing training of teachers, introduction of contemporary teaching and learning methods, and through facilitation of personal and professional career of every individual participating in the education process, there still exist areas for continued development. The primary goal of the education policy should focus on providing opportunities to all age groups to acquire a suitable educational level, and to ensure that all possess competencies commensurate to the demands of society and the labour market.

There are 21 higher education institutions in the country, out of which seven are public universities. Higher education implements under-graduate, master and doctoral studies in the higher educational institutions and institutes which are autonomous and independent. In the recent years the number of students, both regular and part-time, studying at Macedonian universities is steadily increasing. Therefore, this period is suitable for even faster development and improvement of the educational system. The funds to conduct the basic activity in higher education are provided through the budget of the Republic of North Macedonia. Each higher education institution individually determines the required amount of funds in conformity with its annual program and then submits this to the Ministry of Education for approval. The majority issues concerning the education system fall under the insufficient amount of funds required for the faculties. For instance, the Faculty of Mechanical Engineering in Skopje, requires budget for the laboratories, so they are fully equipped with the instruments required to conduct advanced research and increase the practical experience of the students, which cannot be covered only with the provided budget of the Ministry of Education.

The Republic of North Macedonia is a developing country, where the country's standing in global economic rankings have to be improved. The key economic indicators such as growth, jobs, and income, due to the frequency of the changes and the lack of consultative processes are not fully developed. Entrepreneurship and workforce skills are not keeping pace with the evolving market which further inhibits growth. Through that the country is attracting foreign investments to its technological and industrial development zones, wherefore the overall investment level outside these zones remains low. Over the past several years the number of big companies is decreasing, thus improving the competitiveness of micro, small, and medium-sized enterprises that have the potential for growth and job creation. This causes the university-industry interaction to constantly go down over the years and it is extremely important aspect that should be changed. Many employers are seeing low potential in candidates to fill the jobs they need and develop their businesses, because many of those candidates are lacking in key skills and are not educated and experienced enough to take the real work obligations right after their studies. These new companies do not have the capacity for specialization and do not invest lots of money and time to improve the practical experience of the new candidates. For the working positions they require already experienced and high-profile graduates, who are already independent, speak foreign languages, and are capable to work in teams. The engineering graduates are expected to have knowledge in different softwares, modeling, simulations and to keep up to date with newest technology. In order to close the skills gap, the establishment and maintenance of collaboration between the University and industry is increasingly significant. All the skills needed for students to be career-ready can be improved and that can prepare them better for the challenges of a career.

Nowadays, large numbers of educated and professional people departure from the country, usually to live and work in another one where pay and conditions are better. Also, there are lot of students who go to the more

developed countries to learn in the universities that offer better level and quality of education. Furthermore, the students go abroad for internships to gain practical experience, due to the insufficient offers and not efficient options for internships in the country. Unfortunately, after they finish with the education process and the internships lot of students do not return to the home country which plays a negative role in the efforts toward sustainability and capacity building. In order to change this, everything needs to be done to attract the students to return back or stay in the home country by creating better conditions for higher quality of education and providing good and new jobs. With involvement in Project Hub activities and direct connection with the companies, they can become more experienced and work on projects they can later write in their resumes, which will lead them to more job opportunities.

3. Project Hub: Goals, Objectives, and Activities

The Project Hub provides a university-industry partnership where student design projects benefit clients and industrial sponsors interact with students and faculty to help us create excellent engineers and make a significant difference in engineering education at Faculty of Mechanical Engineering – Skopje. Teams of engineering students have a great opportunity to work on real-world problems, to understand industry's needs and apply the knowledge and tools acquired during their undergraduate education to help solve engineering problems. Industry sponsors have a unique opportunity to partner with the faculty to help educate the next generation of engineers and future high-potential employees using facilities for design, prototyping, and fabrication. Since its inception in 2017 and within only 2 years fulfilled with intensive work, the Project Hub has completed 20 student projects, cooperated with many different industry sponsors, and nearly 100 engineering students at Faculty of Mechanical Engineering – Skopje participated in such projects. All students during the whole process of researching and completing the projects work under the mentorship of the employees and the industry sponsors, as well as professors and members of the commission from the Faculty of Mechanical Engineering – Skopje. The students who participate can work in fully equipped laboratory on projects with various innovative topics which are funded and logistically supported by the Faculty. Furthermore, the Project Hub organizes public events where the students have the opportunity to present their projects with the characteristics and specifications of their final products and its commercial potential. The main goal is to encourage and develop entrepreneurial skills by presenting a product that further needs to be presented and developed in a particular company.

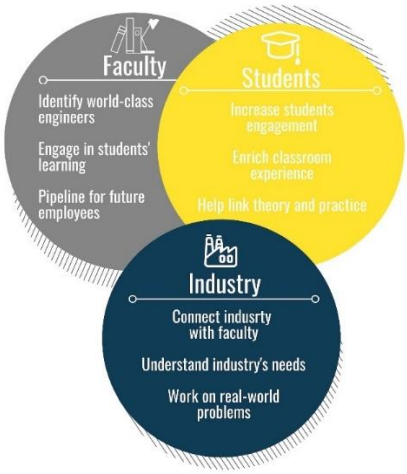

Figure 1 Diagram: Industry - University Partnerships.

Project Hub has many different strategies for maintenance of the partnerships between the industry and the faculty, therefore providing benefits for both of them and preparing high-profile students. The first type is solving of engineering problems that the companies are facing. The students work individually or in teams to find different solutions and approach to the problems, under the mentorship of the professors from the faculty or mentors from the company. There is a grant provided by the company in purpose to cover all the expenses for the problem to be solved by the students. This is a great opportunity for the companies to develop a new product, present a new technology and promote their products or different services. Furthermore, there are competitions supported by the companies where they give many challenges for the students. The hardworking students who have a desire for success and are able to accept additional work can apply on these competitions. The team work and collaboration with mentors from the company is a great chance for them to gain a lot of experience and motivate them to win and find the best possible solution, make prototype or improve some of the existing products. Moreover, the students can work on applied research projects under mentorship of the professors from the faculty. There are many specific projects which require a lot of work and commitment including consulting,

quality control, testing, certification, and prototype development. In addition, the focus on soft skills development for better preparation of the students for the working environments after they graduate is very important. This includes training of writing papers and preparing presentations in English language, improvement of time management, as well as teamwork capabilities.

4. Success stories of Project Hub

4.1 Grant writing workshop and scholarships for students from all study programs

At the very beginning of the establishment of Project Hub, the grant application workshop was held, at which all the employees of the Faculty of Mechanical Engineering - Skopje were invited to participate. At the workshop, the coordinators shared their ideas and expected results and the participants had the opportunity to improve the knowledge and skills for writing grant applications.

Faculty of Mechanical Engineering – Skopje offers full scholarships to students which cover the whole duration of the studies. The students who have the highest scores of the testing conducted by Project Hub receive the scholarship. In 2017, 71 students were tested, and the top 6 were awarded a scholarship. The Project Hub provides scholars with excellent working conditions at any time of the day.

4.2 Student competitions: TeamWin, Team2Win and Solutions for the company Henk Cruiser

TeamWin and Team2Win are student competitions organized in cooperation with the company Rade Koncar TEP. These competitions revolve around solving a real case given to the competitors. In total 18 teams with 72 students participated in the competition. The goal is to find a solution using the information provided in the case and work on a free topic, or on the design of a pellet stove. The students had the opportunity to work on real-world engineering situations under the mentorship of the members of the commission from the Faculty of Mechanical Engineering - Skopje and the employees of Rade Koncar TEP. Also, students had a chance to gain substantial experience, showcase skills, analyze and evaluate outcomes, uncover personal aptitude, develop their ideas and skills, as well as win great prizes.

In cooperation with the German company Henk, Project Hub organized a student competition on which students were assigned to propose constructive solutions to some of the problems that the company has in the development process of its new product. 4 students submitted proposals which were publicly presented before the committee in composition of professors and employees from the company. The solution for production of electricity from rolling the suitcase proposed by two students was chosen for the best. The best solution will be implemented in the new product Henk Crusier. Also, the company Henk will reward the students with a luxury product from the company worth from 6,000 euros.

4.3 Project Hub: 3-Minute Pitch Event

The Project Hub organized the Project Hub: 3-Minute Pitch event, where students from the Faculty of Mechanical Engineering - Skopje from different study programs presented their 10 projects. With a 3-minute presentation, the project teams presented the characteristics and specifications ot their final product and its commercial potential. The main goal was to encourage and develop entrepreneurial skills by presenting a product that further needs to be presented and developed in a particular company. All teams were appropriately evaluated by the audience at the event and the evaluation committee of the presentations with the members: Prof. Dr. Darko Danev - Dean of the Faculty of Mechanical Engineering – Skopje, Capie Polk Baily - Wife of Jess Baily, the U.S. Ambassador to Macedonia and Diana Despodov - Executive Director of AmCham Macedonia. According to the ratings of the commission and the votes of the audience, the best presentations had student teams with the projects Bio-inspired Modular Robot and Smart Fashion: Wearable Mechatronic Devices.

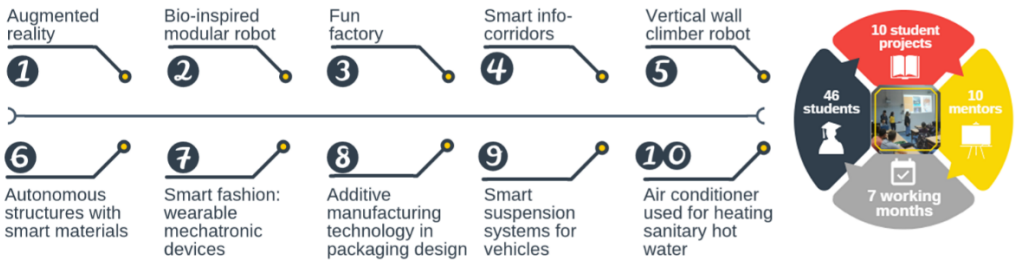

Figure 2 Student projects on the event Project Hub: 3-Minute Pitch

4.4 Student engineering projects

Project Hub enables students to work on projects under the mentorship of the teaching staff, which are funded and logistically supported by the Faculty. Altogether there are 10 projects and 46 students are involved, working on various innovative topics. Project work challenges students to think beyond the boundaries of the classroom,

helping them develop the skills, behaviors, and confidence necessary for success. The projects require collaboration, creativity, problem-solving, and innovation that helps prepare students for work environments.
The various topics of the projects prepare the students to work on real problems, while presenting many innovative ideas and solutions for problems that also the companies are facing. Therefore, the companies also have lot of benefits to collaborate and work with the students during the working period until they make the final products. The topics of the projects are suitable and of great interest to many different companies, due to the fact that they vary from making wearable mechatronic devices that can be integrated into clothing, to creating a biologically inspired robot, as well as using the augmented reality to enable the reader of any printed content to reinforce reality by adding 3D animations.

5. Conclusions

The Project Hub, as a connection between the students, the faculty and the industry provides an effective way for developing theoretical and practical knowledge in a real production environment. Project work challenges students to think beyond the boundaries of the classroom, helping them develop the skills, behaviors, and confidence necessary for success. The projects require collaboration, creativity, problem-solving, and innovation that helps prepare students for work environments and increases the student job opportunities. The students who are involved in all activities have a chance to gain substantial experience, showcase skills, analyze and evaluate outcomes, uncover personal aptitude, develop their ideas and skills, as well as win great prizes.
Engineering students gain practical hands-on experience through industry-sponsored and client-based design projects. Industry-sponsors of the projects experience benefits as well. These include having a wider variety of perspectives approaching the design problem and a larger team working on the project. Teamwork can increase productivity and the student projects often result in deeper engagement from students on the design problem.

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A PROCESSUAL MODEL OF QUADRUPLE HELIX COLLABORATIONS

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Abstract

Collaborations between industry, government, knowledge institutes and civil society, also known as Quadruple Helix Collaborations (QHCs), have been proposed as an effective and responsible way to tackle complex societal problems. Traditionally, these collaborations are modelled from a stakeholder-analytical perspective, meaning that the model focuses on the different stakeholders that are part of the innovation process. In this paper, we argue that the stakeholder-analytical approach of quadruple helix collaborations creates methodological problems and propose an alternative: a processual model of QHCs. In this model, the helixes are conceptualized as interacting processes of value co-creation (as opposed to groups). We illustrate the use of this model with a study of how processes of value co-creation can clash with each other in real-life cases of QHC. We distinguish four types of clashes: contrariety, contradiction, resistance and disparity.

Keywords
quadruple helix collaborations, stakeholder analysis, process analysis, organisational clashes, value co-creation.

1. Introduction

A *quadruple-helix collaboration* (QHC) is a form of research and development (R&D) in which industry, government, knowledge institutes, and the civil society collaborate towards mutually recognized innovation goals [1],[5],[13], [14].[13] QHCs are seen as sources of solutions to *complex problems* such as sustainability, terrorism and affordable healthcare. Typical of such complex problems (also known as 'wicked problems') is that they are underdefined and resist isolated solutions that do not take the larger socio-economic system into consideration [36]. For this reason, individual sectors regularly fail to deliver direct solutions because, by working alone, they only see one side of a multi-faceted phenomenon.

QHCs promise more problem-solving capacity because through the collaboration of stakeholders that approach such a complex problem, the degree of understanding is thought to increase and thereby, it is believed, the probability of triggering innovation processes that can bring us, more rapidly than otherwise, towards solving the problem in question [18]. [22]. Aside from this increased problem-understanding and problem-solving capacity, QHCs promise a more inclusive, responsible form of innovation. The idea is that, given the breadth of stakeholders participating in the innovation process, the interests of these sectors will be better represented leading to more innovations that are attuned to societal concerns [10]. The inclusive aspect of the QHC, particularly the inclusion of those impacted by the innovation [59], makes QHC a promising way of doing *responsible research and innovation* [56]. Advocating the inclusion of all major societal groups and thereby incorporating these groups' values, QHCs can be seen as the modes of doing responsible research and innovation. Therefore, it seems that QHC are *the way to go* in tackling complex problems responsibly. This view has been proposed and substantiated by numerous studies.[14]

The concept of QHC has received little attention from a methodological point of view. Most of the works cited above have taken a programmatic stance or have sought applications of the concepts while others have delved into the philosophical questions arising from such collaborations [7]. A common element in all these studies is their adoption of the *stakeholder-analytical* stance. The stakeholder-analytical approach is, however, difficult to operationalize. This is primarily because it relies on the notoriously slippery concept of stakeholder identity (or, more slippery still, *sector* identity). Additionally, the stakeholder-analytical approach emphasises stakeholder *participation*, as if participation is an end in itself rather than the means to an end.

In this paper we propose a process-analytical model of QHCs. In this model, the four helixes are conceptualized as *processes* instead of (stakeholder) groups. Specifically, we define each of the four helix as a process of *value co-creation* [2]. In this way, research into QHC processes need not draw artificial lines between organisations and sectors and the research focus lies, not on stakeholder or stakeholder participation, but on the value co-creation processes (whether these processes proceed complementary or clash with one other). We illustrate the use of this new conceptualization, and the shift in focus, by looking at three processual clashes in real-life cases of QHC. Understanding processual clashes is important because these phenomena hamper a good collaboration between stakeholders. Additionally, they create a sense of frustration when a clash is ignored or, worse, when it is resolved by patently favouring one value over another. It is thus necessary to create a model that aids the identification of the values involved in a particular clash and the kind of clash occurring. Both these analytical steps are necessary preliminary steps for solving the clash and moving forward in the QHC collaboration.

The paper is structured as follows. In section 2, we take the current research on the QHCs as a starting point and explain the need for a processual turn in conceptualizing QHCs. We answer this need by showing how the four helixes can be conceptualized as processes of value co-creation. In section 3, we explain the methodology for illustrating the use of the model: the method employed for data collection, data analysis and data representation. In section 4, we illustrate the use of the model by applying it in a study of real-life cases of QHC. In section 5,

[13] Quadruple helix collaborations ('QHCs', henceforth) have also been discussed under the label of cross-sectoral partnerships or multi-stakeholder alliances (Andrews & Entwistle, 2010; Bryson et al., 2006; Bryson, Crosby, & Stone, 2015). In this paper, we consider quadruple helix collaborations and cross-sectoral partnerships to be synonymous, but we will employ the term QHC throughout for the sake of consistency. The semantical differences between these terms are not important for investigating collaboration challenges between the four mentioned sectors.

[14] To be sure, these studies are not universally eulogizing on the idea itself, nor do they necessarily see the idea of the four stakeholders groups working together as something particularly new, but they all almost invariably take the stance that a QHC innovation process *can* be an appropriate strategy for approaching wicked problems (Ahonen & Hämäläinen, 2012; Arnkil et al., 2010; Campanella, Della Peruta, Bresciani, & Dezi, 2017; Carayannis & Campbell, 2014; MacGregor, Marques-Gou, & Simon-Villar, 2010; Monteiro & Carayannis, 2017)

we discuss the policy implications of the obtained results and the model lying at the basis of this research. We conclude in section 6 with suggestions for further research.

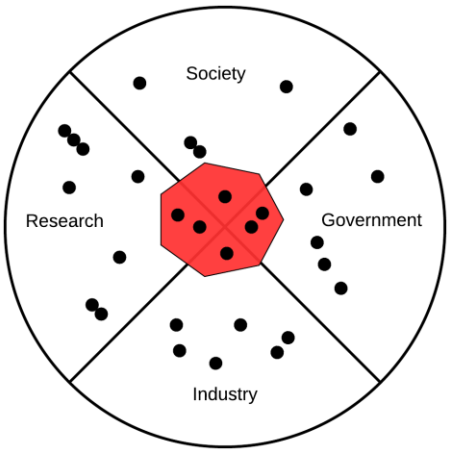
2. The Quadruple Helix: from stakeholders to processes

2.1 The stakeholder-analytical approach to QHC

The origins of the term 'quadruple helix' need to be sought in the late 1980s when scholars and practitioners of innovation studies expressed a general disagreement with traditional models of innovation (see e.g. [5], [40], [57]). These traditional models viewed innovation as a linear process from fundamental research to applied technology and assumed that innovation was primarily an interplay between the state and businesses. Of the many alternatives to this tradition that were subsequently proposed, one is relevant for the present purposes: the *triple helix (TH) model* [26] [44] [45].

The TH model postulated that innovation result from collaborations between industry, knowledge institutes and policy makers. The model was proposed by Etzkowitz and Leydesdorff as an analytical tool, meaning that its function was to shed light upon the immensely complex process of innovation [44]. Specifically, the triple helix model was initially introduced to understand the new role played by *knowledge institutes* in innovation given that the output of these institutes has an increasing, long-lasting, systemic effect on society and economy [19]. Subsequently, just as knowledge institutes were introduced in the pre-existing state-industry configurations (to form the triple helix), so was the civil society introduced into the triple helix model to form the *quadruple helix* [18] [19]. The fourth helix is often defined as "media-based and culture-based public" which effectively includes any individual who is or could be affected by a certain research and development process and thus has a reasonably clear stake in the process [20]. The public, while not necessarily trained to grasp the technological and economical dimensions of an innovation process, shapes this process in indirect ways: "culture and values, on the one hand, and the way how 'public reality' is being constructed and communicated by the media, on the other hand, influence every national innovation system" [18]. A quadruple helix collaboration event is thus, according to the model, the direct or indirect participation of at least one organisation from each of the four helixes. In Figure 1 we offer a representation of such an event with the four helixes distinguished accordingly.

Figure 1 QHC represented traditionally as a collaboration event (in red) where different stakeholder groups are represented by individuals (dots)



The metaphor of the 'helix' is surely very apt to capture the intertwining of forms of knowledge that are activated within the innovation process through the participation of the different stakeholders. However, it poses methodological problems when we try to operationalize the model for empirical research.

The first problem in operationalizing the model is that the four labels denoting each helix remain a matter of personal interpretation. In the original formulation, the four helixes are defined as follows: (1) academia/universities, (2) industry/businesses, (3) state/government, (4) media-based or culture-based public [18]. A similar delineation is employed by Bryson, Crosby and Stone in the following definition of cross-sectoral partnerships "by cross-sector collaboration, we mean partnerships involving government, business, nonprofits and philanthropies, communities, and/or the public as a whole [14]. But what is behind these abstract labels? There is no universally accepted definition of 'research', 'industry', 'state' and 'public'. Furthermore, given the complexity of these phenomena, one might even wonder whether such a definition is possible or useful. Our own experience with the chaotic reality of inter-organisational collaborations has taught us that drawing artificial lines

to delineate groups according to these labels is almost impossible. But if we cannot delineate the four groups in practice, how are we to determine whether an observed collaboration event is a case of QHC?
The second problem in operationalizing the model comes from the other side, so to speak: the organisations that are be assigned to one of the helixes. As socially constructed entities, organisations - their resources, their activity and their output - will inevitably evade strict definitions and classifications. Complex institutions that are active on a variety of fields will have more than one (overlapping identities) and it is not immediately clear which ones of these identities is to claim pre-eminence over others. An institutional identity is always in the eye of the beholder [51]. Going back to the task of assigning organisations to groups, we must ask ourselves: What feature of an organisation do we then take as the decisive ones for assigning an organisation to a certain group? Are we to divide groups based on their institutional aim, the organisation's actual activity or on their institutional alliances and allegiances?
Let us illustrate this second problem by taking the example of a concrete organisation: the Institute for Sustainable Process Technology (ISPT) active in The Netherlands.[15] The institute describes itself as a network organisation for the process industry in The Netherlands, so the first instinct could place it under the industry helix; on the other hand, the institute is actively involved in tackling sustainability issues within these industry (energy reduction, circularity etc.)_so we might also say that they are lending their efforts to a socio-ethical cause. Thus, given that ISPT is not simply there to help the industry turn investment into profit but has a broader social agenda, ISPT is part of the civil society. Further, within ISPT there are PhD candidates and Master students carrying out research and their research output is actively used within the institution and by other scientists. In this light, ISPT is a research centre. And finally, given a broad definition of policy-making [29], one that would include not only the activities of actual policy-makers but also other bodies that participate in agenda setting and public-private interaction, ISPT is influencing the overall governance of the process industry. So this organization can also be placed in this public sector. We see therefore how, by placing ISPT on the backdrop of its different contexts of activity, we can reveal a multitude of social constructions. As an object of organisational analysis, ISPT is, as all other organisations are, in the eye of the beholder.
A third problem runs deeper into the philosophical assumptions behind QHC. In working with the QHC model, Carayannis and Campbell have stressed the *participation of stakeholders* as essential for high-quality R&D. This participation is described in terms such as "co-development", "co-evolution", "co-specialization" [18]or in phrases such as "pluralism of knowledge modes" and "cross-integration of different knowledge modes (2009, p. 208). In full:

> [Knowledge production in QHC] engages actively higher order learning (learning, learning-to-learn, as well as learning-to-learn-how-to-learn) in a multilateral, multimodal, multinodal, and multilayered manner involving thus entities from government, academia, industry, and civil society as well as driving co-opetition, co-specialization, and co-evolution resource generation, allocation, and appropriation processes that result in the formation of modalities such as innovation networks and knowledge clusters" [20].

Leaving aside the ambiguity of these terms, the suggestion is given that the quality of QHC stems from the participation of stakeholders. The dictum would be: If a R&D event is to be a QHC event, then stakeholders from all four sectors must participate. This focus on participation of stakeholder from different corners of society is very much in line with the literature on responsible innovation [33] [34] [39] [56] as well as with the more general trend that seeks to democratize research and development [24] [27] [37] [38] [53]. While insisting on stakeholder participation might be welcome as a way to change tides in research policy, participation cannot be the goal in itself when turning to the real-life. In real life, participation is very complex and it's not always conducive to stakeholders defend their interests. Participating stakeholders do not always manage or even want to defend their interests even though they're as involved as one can be. Other times, they might not be directly aware of their interests, especially in the beginning of an innovation projects where inputs (resources) and outputs (products) are unclear. It seems to us then that participation is not the end result but the starting point.
We have identified three problems with the stakeholder-analytical approach to QHCs. First, we have shown that the *helixes* are too complex to allow a simple four-fold system. Second, we have shown that *organisations* are too complex to allow straightforwardly ascribing them to helixes. Third, we have shown that the *activity* of organisations in helixes is too complex to be pinned down to labels and does not seem to be the end-goal anyway. Based on these three problems, we conclude that, modelled from a stakeholder-analytical approach, a stakeholder-based QHC will present serious operationalization challenges. These challenges are relevant for the future implementation of the model because a good metaphor is not enough for capturing a phenomenon – the further elaboration of this metaphor is crucial for actually using the metaphor as a starting point for empirical research. In what follows we will propose such an elaboration.

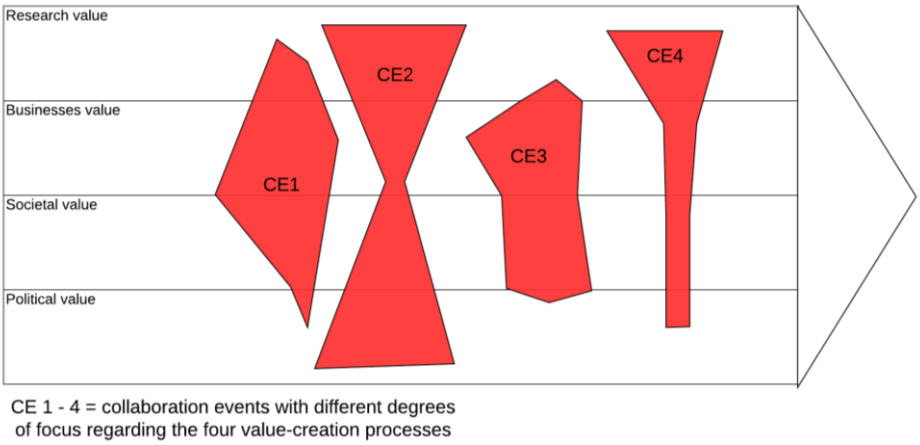
[15] For more information about the institute, see www.ispt.eu

2.2 A processual model of QHC

In order to improve the operationalization of QHC, we suggest that helixes are to be conceptualized not as groups of organisations but as processes of *value co-creation*. These processes cross-cut traditional delineation of sectors and organisations. The concept of value co-creation stems from management science and has been defined as "the joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically" [30]. One of the fundamental assumptions within the co-creation literature is that organisations cannot create value but only value *propositions* and that in collaborates with other stakeholders in order for a value proposition to become actual value – in this way, value is *co*-created [2]. In the business context, where this concept was originally applied, this means that the consumer *participates* in the value-creation process together with the provider. In an innovation context, it means that the innovative process consists of propositions of various forms of value and that the interaction between stakeholders turns these proposals into reality. This view on innovation is sometimes referred to as 'co-innovation' and postulates that innovation takes place on a "platform where new ideas or approaches from various internal and external sources are applied differently to create new value or experience for all stakeholders" [43].

If we model QHCs not as a grouping of essentially different stakeholders but as value co-creation processes, the four initial groups (academia, industry, state and the public) are now value co-creation processes and, crucially, *it is the type of value co-created that is the elementary unit of analysis.* In this way, we eschew needless discussions on whether an actor or organisation 'really is' of a certain kind: each helix is a process: from less to more of certain kind of value. We can thus speak of the co-creation of four different types of value: research value, business value, political value and socio-ethical value. These four processes are illustrated in Figure 2 below, where the different value output of several imaginary collaboration events (CE_1-CE_4) are shown through different figures (the wider the red coverage, the more a CE creates that type of value.

Figure 2 QHCs a collaboration event (CE) consisting of the simultaneous but unequal creation of four different kinds of value



The four value co-creation processes distinguished above can each be further specified depending on one's specific research interest. Since *values* are at stake, approaches are bound to differ in scope and focus, but a general thread can always be extracted. For example:

(i) The research helix will refer to co-creation of *research value*. As a social system, academia is organized along the gifts offered by researchers to the community [35]. These gifts take the form of publications, patents etc. and each creates credit (authority) for the authors and those building upon it. Gradually, as more colleagues build upon it, the value proposition is co-created and thus actualized.

(ii) The business helix will refer the co-creation of *business value*. Business value is "the worth in monetary terms of the technical, economic, service, and social benefits a customer receives in exchange for the price it pays for a market offering" [3]. Along these lines, the business value of a QHC output is typically its pecuniary worth on the market but it can also refer to non-pecuniary worth that translates into pecuniary worth only indirectly and in longer timespans, e.g., learning, reputation gains and symbolic rewards [23].

(iii) The policy helix is the co-creation of political value. In any political system, the political value of an action pertains to its capacity of creating or maintaining the rights promoted by that system and thus to the continuation of the system in question [25]. What these rights are is a matter of discussion but for now we can take a general stance and say that, in a democratic system, the political value of an QHC

output is its capacity of leading to the preservation of *democratic rights* [12]. Following the work of Brettschneider, we can further say that the political value of a QHC output is measured against the ideal of "dual commitments to rule by and for the people" (2010, p. 22). In other words, that output is not only the expression of people's will ("by the people") but it is also an output that serves their interest ("for the people").

(iv) The civil society helix is the creation of socio-ethical value. The social value of research and development is the main focus of study in many approaches, from the general approaches such as RRI [49] [56] and technology assessment [52] to more specific approaches such as risk governance [6]. The main message we can extract for the present purposes is that the socio-ethical value of a QHC output is measured against the output's alignment with current norms of social and ethical acceptability (see overview in Garst, 2019). What constitutes social and ethical acceptability is of course subject to variation, but in principle it revolves around the idea that innovation (its input, throughput and output) should be sensitive to the moral and practical needs of society and include these needs early on in the innovation process.

Conceptualizing helixes as processes is a solution for tackling the four problems identified above. First, a processual model allows us to avoid needless discussions about the true essence of each helix. If we focus on the value co-creation processes, matters of stakeholder denomination can be set aside. Of course, it will be up for discussion what exactly counts as 'research value', 'political value' etc., but such discussions are already part of the innovation process. Regardless of their allegiance, stakeholder *need* to explicitly or implicitly establish within a project what type of values they are co-creating and how these values are to be brought about. We might say that the discussion on the value co-creation *is* the discussion on the innovation process, whereas the discussion on titles and affiliations is neither useful nor necessary. Second, a processual model in which value co-creation is centrally placed will not need to pin down organisations to a specific area of knowledge (expertise) or to specific values. During innovation, organisations will naturally navigate the four streams in a fluid way, build their identity in doing so; this process takes place outside (indeed, *despite*) the organisation's fixed narrative. Ignoring this natural process for the purpose of a neat categorisation is now not needed because there is nothing in the definition of the value streams that requires to pin organisations down to a certain identity.

2.3. Case in point: Studying process clashes

In order to substantiate our theoretical proposal, we wish to illustrate how the model can be taken as a starting point in a more systematic study of the interaction between processes, leaving aside organisational identities, allegiances, names and labels. For this purpose, we take a closer look at the interaction between the four helixes (conceptualized as value co-creation processes) and we focus on situations where helixes *clash* with each other. The end goal of this focus is to get a better understanding of the values involved in the clash, the type of clash arising between those values and thus be better prepare to solve the clash.

The term 'clash' will refer in what follows to the situation in which there is not complete agreement on how to distribute resources across the four helixes. In other words, a clash occurs when resources (R) such as time, money and energy and helix' needs of those resources (H) are not fully aligned. In other words, some helixes (i.e., value co-creation processes) might need to be sacrificed due to lack of resources. But not all clashes are the same. We would like to suggest a distinction between three kinds of clashes. These are derived from the well-known *square of opposition* which defines clashes between statements at the highest level of abstraction (Béziau & Jacquette, 2012; Moravcsik, 1968). We thus define four kinds of clashes:

(1) Contrariety. This clash occurs between two processes that need all the available resources: "All resources R for helix H_1" vs. "All resources R for helix H_2".[16] This is the biggest, most conflictual form of process clashes since it creates a zero-sum situation where each process is either fully satisfied or fully dissatisfied.

(2) Contradiction. This clash occurs between a process that needs all the resources and a process that only needs some of the resources: "All resources R for helix H_1" vs. "Some resources R for helix H_2". This is less conflictual since technically there is an agreement between the two processes on the fact that at least some resources need to go towards H_1. However, if H_2 is to be fully satisfied, then H_1 will be partially satisfied.

(3) Resistance: This clash occurs between two processes that need some of the resources designated for that process: "Some resources *R* for helix H_1" vs. "Some resources *R* for helix H_2". This is even less

[16] For the sake of simplicity, we have keep affirmative statements in the examples, but of course everything can, mutatis mutandis, be exemplified with negative statements.

conflictual since the two processes can (but need not) complement each other. Whereas contrariety and contradiction do *not* allow a happy ending where both parties are fully satisfied, resistance allows for such a solution when each process seizes some part of the available resources *R*.

(4) Disparity: This clash occurs between two different allocations of resources for the same helix: "All resources R for helix H_1" vs. "Some resources R for helix H_1". The degree of alignment here is so big that we might question whether this is indeed a clash. After all, fully satisfying H_1 according to the first stance is *necessarily* automatically satisfying the second stance. In practice, however, 'some for H_1' does allow the possibility of 'some (other) for H_2', so some small realignment needs to take place. Disparity is thus more a conflict threatening to happen than an actual conflict.

The four-fold distinction between clashes allows us to be more specific when talking about failures of collaboration in QHCs. But, importantly for the present purposes, it shows that the collaboration in QHCs can be studied without focusing on the stakeholders and their identities but rather by looking at the helixes as value co-creation processes and the resources needed to create the values in question. In what follows, we will present our results from analysing real-life cases of QHC and illustrate some of the types of clashes defined above. It will be remarked, we hope, that nothing in our analyses will hinge upon the identity of a stakeholder, the sector of provenance or even the kind of expertise/knowledge stakeholders traditionally bring to the proverbial round table.

3. Method

In our empirical study of QHC, we interviewed 15 practitioners that have participated in QHCs in the past 5 to 10 years. The four problems tackled in the investigated QHCs were: sustainability (primarily CO_2 reduction), digitalization, smart cities and education. We made sure that the selected individuals were part of the coordinating team of the discussed project so that we can expect them to give us a bird's-eye-view of barriers and their effect on the collaboration. In Figure 3 below we offer a summary of the respondents:

Figure 3 Respondents, affiliation and the tackled problem

Resp.	Institution	Complex Problem
1	University	Digitalization
2	Industry Association	Sustainability (Process Industry)
3	Industry Association	Sustainability (Process Industry)
4	Business	Digitalization
5	NGO	Education
6	Industry Association	Sustainability (Process industry)
7	University	Sustainability (Food)
8	Business	Sustainability (Process Industry)
9	Individual Consultant	Sustainability (Energy efficiency)
10	Industry Association	Sustainability (Process industry)
11	Industry Association	Sustainability (Process industry)
12	NGO	Sustainability (Energy efficiency)
13	Local Government	Smart cities (Transportation)
14	Local Government	Smart cities (Urban development)
15	Policy (advisory)	Education

Each interview consisted of 3 parts of approximately 15 minutes each (45-60 minutes per interview). In the first part, we asked informative questions about the selected QHC: the partners involved, the funding, the goals, and the timeline. These questions were simultaneously intended for information acquisition and to bring our respondents back into the context of QHCs. Most of the information we asked for was already publicly available on the Internet, and yet we started with such a discussion every time in order to call back the details of the stakeholder interaction. Subsequently, in the second part, we asked questions regarding the interaction itself: first we focused on the verbal aspects (questions about communication), second we focused on the non-verbal aspects (questions about the parties' emotions and attitudes). We assumed that, looking back at the interaction (verbal and non-verbal) participants will either themselves take a normative stance or else recall aspects that can be evaluated later. We additionally assumed that respondents would switch from a purely informative tone – used in providing details regarding the project – to a more personal tone – used in describing one's psychological and social experience of the case. This personal tone is then the stepping stone for a full-blown evaluative attitude that was required of them in the third part. In this third part, we gave respondents the opportunity to evaluate the

progress of the project and identify barriers. We first asked the question as openly as possible: "What were the barriers encountered in the collaboration between the stakeholders?" (Note that we did not specifically direct respondents towards a specific type of barrier, since the question can be understood to refer to both intra- and inter-helix barriers).

If respondents cannot come up with barriers or handle one or two barriers quickly we chose one or more of these strategies: (a) ask follow-up questions ("Explain", "Elaborate", "Why?"); (b) ask for drivers instead of barriers, assuming that the lack of needed drivers can be seen as a barrier; (c) asking for known potential barriers identified in the literature such as: access and transparency, management, governance structures, collaboration skills, communication, trust, division of labor [1] [28].

3.3 Data analysis

In order to understand how helixes see the value co-creation process, a phenomenological analysis of their (past) experience and their understanding of these values is needed. To this end, we employed *interpretive phenomenological analysis* (IPA) which recognizes that "that different people perceive the world in very different ways, dependent on their personalities, prior life experiences and motivations" and thus it "attempts to explore/understand/make sense of the subjective meanings of events/ experiences/states of the individual participants themselves" (Smith & Osborn, 2008, p. 229). This form of analysis is particularly appropriate for the context at hand. It is well known that, when complex problems are involved, "stakeholders have different ideas about the problem and its solution in general and about the societal and ethical aspects which have to be taken into account during the innovation process in particular" [11].

IPA is particularly appropriate as an analytical method for open forms of data collection [54]. A questionnaire would be too restrictive to 'get to the experience' and it would also not provide enough depth in order to discover and understand new themes (in our case, new barriers). Given the semi-structured interview described above it is only natural that IPA would be deployed on the collected data. During IPA, the analyst focuses on the language employed by the respondent in describing the events in question and, from this linguistic focus, identifies categories (concepts, term etc.) that are dependent upon – and thus gain meaning within - the institutional logic from which the respondent tells the story. The linguistic focus of IPA is compatible with the assumption that the different worldviews (assumed here to be the four helixes) come with their own semantics. For this type of analysis, it is useful to focus on evaluative terms such as 'practical' 'good' 'strategic' 'effective', and 'reasonable' because it is in these terms that participants couch their normative assumptions.

4. Illustrating the processual model

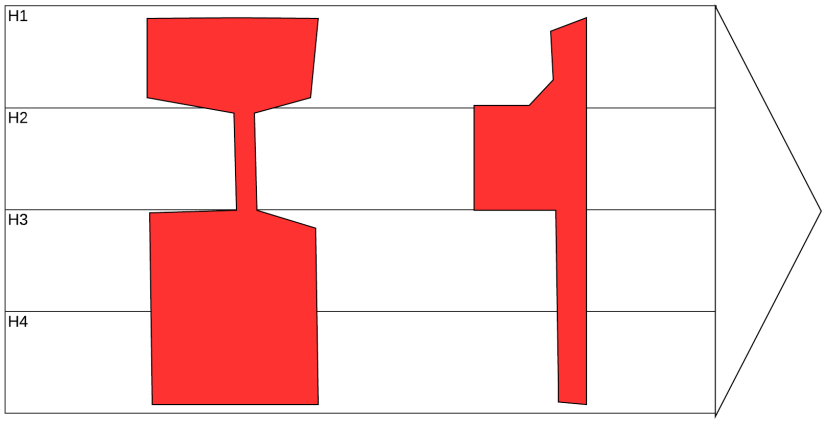
In this section, we take a closer look at several clashes on the basis of model and the derived typology of clashes introduced in section 2 above. We want to show that, in discussing these clashes, there is no real need to pin down individuals to sectors, organisations, or forms of expertise. The type of co-creation processes involved and the kind of clash at issue is all that is necessary to understand the clash in question. We will discuss three examples of clashes discovered in our interviews. In each case, we will introduce an analogy in order to portray the clash in more natural terms that might be easier to remember and to employ in evaluating real-life situations. Some words and phrases needed to be replaced in order to conceal the identity of the respondents and the projects in question.

4.1 The alpha stakeholder

The most prototypical form of clash between two or more value co-creation processes is a contradiction in which some helixes receive *all* the resources and others receiving *none*. When this situation is created by a dominant stakeholder, we will refer to that stakeholder as the alpha stakeholder (alluding to the 'alpha male' or 'alpha female' in the animal kingdom).

The alpha partner pulls the value creation process towards one of the helixes, disregarding other helixes. Of course, some value is created on other helixes as well, but this value is minimal in relation to the value created in the privileged helixes. We can say that that the situation is a case of contradiction: the alpha partner (or partners), pull all their resources towards certain helixes, with little or no value created for the other helix(es). In Figure 4, we give some examples of how the value-creation process is deformed by the alpha stakeholder by showing three disregarded helixes in the left most collaboration event and one disregarded helix in the rightmost collaboration event.

Figure 4 The effect of the alpha stakeholder: two value co-creation processes in which there is a noticeable disregard of one value co-creation process



Respondents have typically elaborated on the sources of authority for the alpha stakeholder. The sources of a partner's authority are many. It can be that the partner is the one influencing the funding structure of the process or that it is the one that other stakeholders see as most knowledgeable, experienced or as having the better network. The partner exploits these sources in order to direct the group one way or the other. Importantly, this imposed direction need not be, objectively speaking, the direction that benefits the partner the most; the partner can exercise power even to its own detriment (perhaps without realizing it).

In many cases, money is a formidable source of power that underlies the behaviour of the dominant stakeholders. Two of our respondents used the following expression to describe how things sometimes work: "Those who pay have a say" (Dutch: Wie betaalt bepaalt). In both cases this referred to a dominant player (one from the industry in relationship to society, thus B2, the other from the local government in relationship with industry, thus B5) who dominated the decision-making process to the detriment of others. The dominance was primarily experienced as a form of closing communication lines. It was seen as an individual trait rather than a generalize inclination of an entire helix ("it's people to people, not organisation to organisation"). The term 'character' is sometimes used ("a dominant character" of someone) which suggests that it is seen as a personal trait.

In two cases, the respondents acknowledged their own dominance in assuming what the other parties wanted and labelled that as a "learning experience". In the first case, there was a clash between the creation of business value and the political value of the product in question. In the excerpt below, respondent describes a situation where the government created a product that is meant to service the industry and the public but encounters resistance on the industry – quite surprisingly since the industry players were the ones who were supposed to be served by the product in question. The following exchange occurred in relation to a series of workshops that were meant to improve the team's knowledge of what the product should look like. But it was only representatives of (local) government and society that were part of these workshops. While these workshops produced "a lot of trust" among these two helixes, it left the industry out:

> Interviewer: And were people from the business sector invited?
>
> Respondent: No. And that was immediately a learning point for us. The businesses, although not necessarily well organized as a sector, held on to their identity. The businesses have always experienced this as a centrally set-up initiative. So even though the sector is not capable of standing up and articulate their question, to then substantiate that, they still experienced that as something that was imposed. They started saying that they don't want this, that they don't need that.

In the second case, there was a clash between the government and other stakeholders (particularly citizens and researchers). This was a situation where the local government thus regretted being too dominant over the citizens, thus a B3 barrier:

> Respondent: We noticed that if you want to make [product] you need all parties. We made the mistake of looking *too late* at society and industry. We at least had the local government. [Respondent then deviates and describes a similar situation where the local government was excluded and ended up rejecting the product altogether] In any case, we learn is that you're allowed to have an opinion, to have

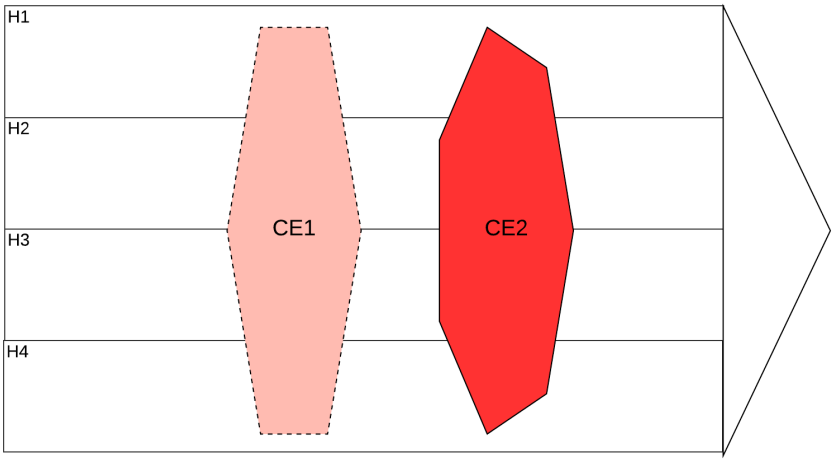
> a vision and to push, but you have to speak to your stakeholders earlier […] a serious stakeholder analysis. Support is something you create *in the beginning*.

The respondent went on to describe how media is particularly attentive to projects that are not created with the collaboration of the civil society and that such cases can lead to negative signals.
In an argumentative form, the dominant partner can be represented as a misplaced argument from authority. An argument from authority aims to establish a standpoint's acceptability based on the opinion's endorsement by a certain individual. It is because this individual is authoritative in one way or another that the opinion then is deemed acceptable – the 'it's true because I say so' approach. Surely, in some contexts, arguments from authority are very acceptable and even common – scientists appeal to authority all the time, whether their own authority or that of others, when referencing and quoting. But in a collaboration, this form of argumentation contrasts the idea of collaboration. The proponent thus advances the standpoint (1) "We should *A*" and, in response to anticipated or expressed doubt from the opponent, supports this standpoint with the argument that a certain individual (or group of individuals) agree that they should do *A*. This leads to a stalemate because the opponent either doesn't accept the other party's authority or does not accept arguments from authority to begin with. In the form of a discussion structure, this conflict can be represented as follows.

4.1 Clash 2: The homing pigeon

This next clash occurs when a partner takes ownership of a task and deals with that task in a concealed way so that other stakeholders have little or no access to the relevant decision-making process. In order to describe this situation, we will use the metaphor of the homing pigeon (the pigeons used to deliver messages) because, once they are given a task, the homing pigeons 'fly away' and is only seen once the task is completed.
The homing pigeon is, in a sense, the opposite of the alpha stakeholder: if the alpha stakeholder deforms the value co-creation process by being overly present; the homing pigeon deforms it by being overly absent. The homing pigeon is also a milder clash than the one created by the alpha stakeholder. This is because the homing pigeon might allocate resources as agreed and might produce value as agreed. In other words: the task might be completed satisfactorily. And yet, since there's no discussion allowed on the decision-making process - no interaction and no access - the clash still occurs. Thus, in representing this clash we will categorize it as a form of resistance ("Some resources to H_x" vs. "Some resources to H_y") and we will illustrate it as collaboration events with areas that 'merely' do not coincide. In Figure 5, we represent this situation by showing the value co-creation process resulting from the behaviour of the homing pigeon (CE2) as only slightly deformed than the one expected (CE1).

Figure 5 The homing pigeon results in a slightly different output whose unknown origin nevertheless creates resistance (clash type 3)



We can illustrate this with the following example. In the excerpt below, the respondent is describing a clash that ensued when the homing pigeon came home with an output slightly more valuable from a market perspective (a solution with immediate applicability in the market) than from a scientific perspective (a more general method that might in the future be applied universally).

> Respondent: [the stakeholder] failed to inform others [of his decisions] resulting in the fact that other team members say "OK but I do not want this solution you are proposing". Then you have a major problem...

> Interviewer: ... a communication problem.
>
> Respondent: Communication is an aspect of it. There's something behind that: the fact that you share a common philosophy of being a team and doing things together. If someone says: ok this is going to be my problem, then you've lost contact with the team.
>
> Interviewer: What are the signals of such behaviour?
>
> Respondent: Often that you don't hear from them in a long time.

Because of its general applicability, the homing pigeon can ensue as a clash between any value co-creation processes that have different conventions for reporting. In the example above, the clash ensued between the production of market and scientific value, where the homing pigeon focused too much on market value, producing a solution that was *too specifically attuned to an organisation* as opposed to seeking a more general solution of scientific value. But we have observed the homing pigeon also in the opposite direction. Sometimes the homing pigeon produce results that are too general (too 'scientific', so to speak) and not specific enough to apply it to market. This is the case in the following example, where the respondent shared the frustration ensuing from the clash:

> Respondent: I'm not going to say a lot about it because I just *hate* how things went… [The other organisation] thought, 'OK, we have money, we're going to do some nice things'. It was a European project so they thought 'Oh, I have European money so I'm going to simply do what I want'. That's my experience also in other projects.
>
> […]
>
> Interviewer: What do you think their agenda was?
>
> Respondent: Well, they have the money! They go ahead and [follow their objectives]. I'm exaggerating a bit but that's what it boils down to. And when they have money they say "so we did this, so we decided to do that"… No, YOU decided to do that. You never aligned with. That is a huge annoyance.

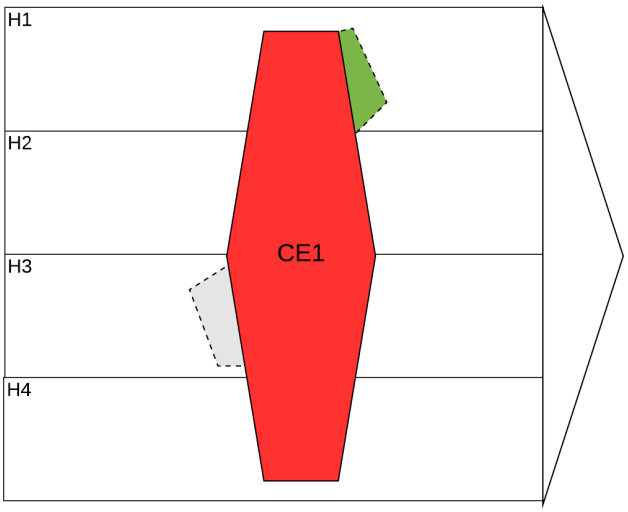
We can see that even though the clash is theoretically speaking more mild (since the homing pigeons might, in their absence, produce results of the expected value distribution) it can still produce significant irritation for the stakeholders who are thereby excluded from the decision-making process. Emotionally, the homing pigeon might feel as a passive form of dominance – through absence – and thus feel as a contradiction and even contrariety. In the example above, the respondent does not say that the solution brought by the homing pigeon is completely wrong: it is the (decision-making) process that was perceived as inappropriate.

4.3 Clash 3: The tortoise collaborates with the hare

This last clash occurs in a situation where stakeholders, while largely in agreement on the distribution of resources, fail to adapt their organisational dynamics and processes to the quadruple helix context. We will use the Aesopian 'tortoise-and-hare' metaphor to refer to this clash of dynamics.

It appeared to be a commonplace that the four value-creation processes have completely different speeds; all respondents have acknowledged this difference one way or another and have seemed to accept it as a given. One respondent, when asked how often these differences become apparent in the life of a QH process, paused for a second and replied: "Almost daily". However, because in R&D speed typically means competitive advantage, the hare (the organisation that works at a fast pace) is more often critical of the tortoise (the organisation that works at a slow pace). On the other hand, the tortoise is in a better position to identify risks and get a better grip on what is happening and thus promotes its lower speed as a source of stability and prudence. The advantages and disadvantages of each approach cancel each other out and create a stalemate. Thus, in order to represent the tortoise-and-hare clash in our model, we have to focus on the distribution of value-creation across the helixes. From the examples given above, we can infer that the clash takes the form of disparity: while the hare allocates all resources to a helix, the tortoise only allocates some. Now, extra speed does not necessarily mean extra value, but it *can* constitute a slight increase in value for one or more helixes; vice versa, extra caution does not necessarily mean extra value, but it *can* constitute a slight increase in value for one helix. We can thus represent this clash as in Figure * below by showing the expected value added by speed in grey (hare) and the expected value added by prudence in green (tortoise).

Figure 6 The tortoise and the hare expect to obtain more value on their helix if extra speed (or caution) is allocated as a resource



In the following example, the respondent describes the difference in dynamics between value-creation processes in industry and a governmental institution.

> Respondent: There is a huge difference in speed between [industry] and [government]. The way of working, decisions, who-does-what... […] Industry is oriented towards the exterior because they are dependent on the wishes of their customers – so that's what they want to develop. While [name government institution] is very much oriented towards the interior. People don't really go outside, figuratively; they have few contacts with [other helixes]. So, after they're trained, they work as [civil servant] and stop looking outside. They do their job and that's it. And because of this the dynamics is different. That's what I meant by speed […] That leads to disagreements. A [civil servant] can very well postpone a task fort wo week whereas in the industry they think: "OK, but I need to know now, am I assigning people to this or not?"

In another case, the hare acknowledged dismissed the tortoise's prudence as being overly cautious. In fact, the hare went as far as considering doing that specific project without the tortoise. In the following exchange, the respondent showed visible irritation regarding the recounted situation:

> Interviewer: Do you remember what the problem was there?
>
> Respondent: They [the tortoise] were very much into accountability. That [we] need to follow all kinds of statutes, and "By the way, where do we stand with the risks? Let's imagine we're going to lose a lot of invested money, who's responsible… that sort of business".

The respondent explained that the situation was experienced as being "held back" by the sluggish tortoise and that at one point was thinking "well if this is how it's going to be we might as well drop it".
The barrier has also been encountered in the relationship between (local) governmental organisations and academia. In one of the investigated projects, led by a knowledge institute, the research partners wanted to investigate an issue thoroughly and get to the bottom of the problem whereas the local government decided to go much faster (and thus riskier) towards an output even if this output was not necessarily scientifically researched. In the same problem, the knowledge institute was following the European regulations regarding privacy to the letter whereas the governmental organisations were looking for ways to avoid this:

> Respondent: I thought, oh my, I'm sure this can be done faster. All these protocols and bureaucracy. As a practitioner, I find that a difficult issue – all those European processes and protocols, accounting mechanisms... That's quite something. I'm more for the approach: you start a collaboration, you get a

certain amount of money, I think that you don't need to follow every point and comma, but you have to be pragmatic about it.

5. Discussion

Being based on a relatively small sample of cases, we do not wish to make a quantitative claim pertaining to the clashes identified above. We simply do not know whether these barriers occur often or even more often than others. Also, we do not wish to claim that these are in some sense the biggest risks in a collaboration. While the clashes in question were given significant weight by our respondents within the separate interviews quoted, this extra focus might simply be the result of an emotional charge with the episodes in question: the more annoying a clash, the easier it was to remember it.

If we relate this approach to the study of process clashes in the past, we notice that the literature on clashes is still very much tinted by the stakeholder-analytical approach. For example, in system approaches, the 'system' typically contains a distinction between sectors. In the past, R&D barriers have been identified primarily based on their origin in one of these identified sectors. For example, taking Geels' multi-level perspective as a point of departure [31] [32], we find categories of barriers according to Geels' socio-technical sectors: scientific barriers, policy barriers, cultural barriers, industry barriers, etc. Similarly, scholars working with other system approaches have come up with different typologies based on the sector from which the barrier originates or the sector which the barrier affects [16] [58]. With the processual model proposed, we replace the question "To which category does this barrier belong?" with the question 'What value co-creation processes clash here, how do they clash and why?"

The focus on clashes (or barriers) might suggest that we are completely ignoring matches (or drivers). While we illustrated the model in this paper with the use of clashes, a similar approach can be taken to drivers. In fact, the four types of clashes introduced – contrariety, contradiction, resistance and disparity - can be read as recipes for resolution. In all four cases, the parties need to address the clash and reach an agreement towards the optimal distribution of resources. In some cases, this optimum will incur a face loss on both sides, in other cases it will incur a face loss on one side. But the answer is always turning a clash into a match. Of course, this abstract description of a match needs further conceptualization that can help us understand *how* the clash might be turned into a match.

We would like to add some thoughts on the notion of QHC itself. The metaphor of a helix does seem to fit a processual approach, but the notion of *collaboration* is still deeply rooted in the stakeholder-analytical tradition. Collaboration (or partnerships) is something that occurs between two or more entities that are essentially different but episodically united. With a focus on the value-creaion process, we propose a way to see past this aspect of the QH phenomenon and focus on the attributes of the output. It might therefore be more in line with the current direction to speak of Quadruple Helix Co-Creation (or Co-innovation) in order to capture the exact features of the proposed model.

6. Conclusion

In the present paper, we have proposed a processual model of quadruple helix collaborations and have explained the three advantages of this model over previous ones. First, by using this model we do not need to arbitrarily define groups of individuals or of institutions but rather focus on the identifiable values that are produced by an R&D process. Second, by using this model we do not need to assume that institutions maintain a steady identity, keep to their helix and are never concerned with other forms of value co-creation. Third, stakeholder participation – while advisable – is not seen as a good in itself but rather as a way of equalizing value co-creation to avoid obvious skews and oversights. Because of these three problems, the model poses operationalization problems because even the identification of an R&D process as a QHC becomes immensely problematic.

As an alternative, a process-analytical approach leaves aside questions of names and affiliations and focuses on the value co-creation processes in R&D. We have identified these as: research value, business value, political value and societal value. The value co-creation processes are supposed to intertwine smoothly but in reality, they often clash because of limited resources – that is, you cannot maximize all kinds of value all the time. This inability to find solutions for maximizing each kind of value has been noted to lead to "distrust, conflict, and premature failure" [42]. We have therefore chosen to study these clashes from a process-analytical perspective. Four types of clashes were identified, from the most conflictual to the least conflictual: contrariety (all resources to a process vs. none of the resources to that process), contradiction (all resources to a process vs. some resources to that process), resistance (some resources to a process vs. some resources to some other process), disparity (all resources to a process vs. some resources to that process). Some instantiations of these clashes were identified in real-life cases of QHC and analysed through an application of the model.

As a strategy for further research, we believe that the conceptualization of helixes as value co-creation processes is a much safer way of modelling QHCs because it places the emphasis on what needs to be done rather than who needs to be present at the proverbial round table. In a descriptive model, these matters are perhaps be less important; one descriptive model focuses on groups, the other descriptive model focuses on processes – it's a difference in flavour. But the quadruple helix model is a normative one. The model describes the world as it

should be, not as it is.[17] A focus on groups promotes the thought that individuals can contribute to R&D only as far as their titles go; accordingly, in the traditional model, the needed "pluralism of knowledge" [18]is reached by bringing in people with different titles in order to obtain the appropriate mixture. In our experience, practice has repeatedly refuted this idea. Broad stakeholder participation is extremely unpractical and, even when it is achieved, it gives no guarantee that the output will adequately cover all four types of value. The standard power-play is, in our experience, the *modus vivendi* in many R&D projects. With a focus on processes and their outputs, we implicitly allow for different stakeholders to create value beyond their business card.

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RESOURCES FOR RESPONSIBLE INNOVATION OF SMES: CASE STUDY IN A GREEK COMPANY

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Abstract
Responsible innovation (RI) is a concept that has recently gained attention, particularly in Europe. Literature review reveals that the concept of responsible research and innovation is of major importance for the performance of an SME. However, this concept and its relevant studies are at a very early stage, both at European and at a Greek level even further. Due to this, our work focuses on the concept of RI in general, but emphasizes on the exceptional resources needed for its implementation. More precisely, the purpose of this paper is to study the resources that SMEs need, in order to develop RI. Based on a former study on Nordic SMEs, a case study analysis for a Greek company of the environmental sector is developed and the findings with the already existing findings of two Nordic companies are compared, revealing interesting conclusions.

INTRODUCTION

Responsible innovation (RI) is directly related to our everyday life engaging in society, incorporating the dimensions of gender and morality, ensuring access to research results and encouraging formal and non-formal

scientific education. At the Council Competitiveness, which took place on the 4-5 December 2014, responsible research and innovation was characterized as follows: "*Responsible research and innovation is a process for better align research and innovation with the values, the needs and the expectations of society*" [17]. It requires close cooperation between all interested parties in various strands, including the scientific education, definition of research programs, access to research results and the application of new knowledge in full compliance with gender and ethics issues.
Nowadays, we have to recognize that there is a regime shift in the evolution of science and its interactions with society for many reasons. These are, globalization, changes in European and global society, new forms of urban and rural lifestyle, new standards of consumption and mobility, new and more diverse forms of family. This shift in the interactions of science and society has been discussed and analyzed in various contexts and has been reported as "Redefining science in society" [20]. The narratives of the relationship between science and society, its importance, its degree of urgency and its types of activities that need to be launched in response to these estimates, depend on the adopted regulatory approaches. This means that learning-interaction must be important for science, for society and for responsible research and innovation. Action Plans mobilization and mutual learning in the context of responsible research and innovation should support cooperation between researchers and citizens in the research cycle, from the definition of research programs to the exploitation of research results.

As deduced, the concept of responsible research and innovation is of major importance for modern reality. However, we note that both the concept and the relevant studies developed are at a very early stage both at European level, let alone in Greece [28]. Furthermore, the previous research on responsibility in SMEs focus, has been on values driving responsibility, barriers discouraging it and the means needed to enhance responsibility management in SMEs [28] [31].

Therefore, this paper describes the concept of responsible innovation in general, but emphasizes on the resources needed by an SME for its implementation. To do so this study has been divided into two parts. The first part is the theoretical, where detailed research is outlined through an in-depth analysis of articles and programs at a European level. This review will help us identify the risks of innovation in social and environmental levels, in order to address them through various actions of responsible research and development. The second part includes the research conducted, where a case study on responsible innovation is carried out in a company of the Region of Western Macedonia, namely DIADYMA, and the findings are compared with previous findings based on a former study of Nordic SMEs. Through a qualitative content analysis (QCA) and a comparison of three different innovations, we intend to identify which resources are necessary and whether we can replace others, so that an SME reaches its ultimate goal of realizing responsible innovation.

REVIEWING RESPONSIBLE INNOVATION

The term "Responsible Innovation - RI" was created in Europe and the United States in the first decade of the 21st century. Among the first authors who have developed this concept since 2003 were Hellstrom, Guston, Owen, Robinson and others. At European level, the concept derives from visions of collaborations between social and natural scientists that face the wider dimensions of science and innovation from the beginning. Examples can be found in the context of the 5th and 6th EU Framework Program, where there was a demand for socio-technical integration. The specific use of the term "Responsible Research and Innovation - RRI" first appeared in the 6th European Framework Program for nanotechnology and life sciences [33]. Responsible Research and Innovation (RRI) is a term used by the European Union's Framework Programs to describe scientific research and technological development processes that take into account effects and potential impacts on the environment and society. In the United States of America, many ideas that have shaped their scientific policy emerged from the writings and influence of Vannevar Bush (1945). In the “Science-The Endless Frontier”, Bush (1945) proposed the development of a policy organization that will support responsible research to meet national targets. As we can see, the notion of responsible innovation has emerged in recent decades, as the need for responsible innovation management was raised between scientists, political actors and the public due to concerns dealing with the products and the goals of innovation activity. The EU-policy argues that RRI is considered an inclusive approach to research and innovation that ensures that innovators and societal actors work together during the entire research and innovation process, aiming to better align both the process and outcomes of research and innovation with the values, needs and expectations of European citizens. Yet there are many questions for innovators to answer on “how to” bring these concepts into reality, as well as what resources are needed by SMEs for responsible innovation.

The study of a Resource Based View (RBV) has gained a lot of interest over the past decade, paying special attention to strategic management as well as the economy, organizational theory and other areas (e.g. intellectual capital). The concept of RBV was first studied in the literature by Wernerfelt (1984) and is based on the theory that the success of an enterprise is largely determined by the resources it holds and controls. Resources can be classified in many ways, they are here seen as comprising of tangible or intangible assets (Wernerfelt, 1984), the former consisting of financial and physical resources, and the latter of human, social, organizational and

technological resources, and reputation [21] [22]. According to [24] and [18], intangible resources are identified as either assets (what the firm has) or capabilities (what the firm does). "Capabilities are immaterial sets of skills and accumulated knowledge, formed through organizational routines" [29] [35]. Consequently, the resource constructs are conceptualized as: 1. Tangible resources which include (a) financial assets and (b) physical assets. 2. Intangible resources assets which include (a) intellectual property assets [23], (b) organizational assets [12] and (c) reputational assets [32]. 3. Intangible resources meaning skills which include capabilities [23] [1].

Literature argues that company's resources are important factors to achieve a competitive advantage and superior performance if they have specific characteristics [12]. Small businesses are more resource-constrained than large companies, which may limit them to produce innovations [14] [34] [30].

But recent surveys show that even if an SME lacks of resources, this is not an obstacle for innovation development [19] [20], and that responsible SMEs can find ways to compensate for resource gaps [16].

The aforementioned suggest that it is worth exploring the resources behind RI in SMEs, in order to better understand the potential for such innovations.

DATA AND METHODOLOGY

Two main research methods were employed in this study. First desk research undertaken, focused on a thorough literature on RRI and global best practices. From the desk research we concluded to our unit of analysis which is responsible innovation for SMEs. Based on a research already conducted by [25] we constructed a questionnaire that depicts the form of a responsible innovation, namely environmental or social and the type of RRI according to two aspects, (i) social and environmental innovation and (ii) design, business model and technology innovations. This study examines 13 small and medium-sized enterprises and controls the combinations of the resources they used for responsible innovation.

Second, taking into account the desk research results fieldwork was carried out for the case study of an environmental SME of the region of Western Macedonia - Greece. The initial thinking in the aforementioned region was to study 5 enterprises of social and environmental nature, but after a first telephone interview we found that there was too much ignorance about the meaning and role of the RRI. Moreover, the studies conducted in Greece were very limited in order to have a data for comparison. For the abovementioned reasons we used the study of Halme and Korpela for comparison and decided to apply a single in-depth case study to an environmental enterprise in Western Macedonia, namely DIADYMA. Detailed definitions and examples were used in our questionnaire to increase response accuracy in our case study. Data were collected through three interviews with decision makers in the enterprise. Interviews lasted from 60 to 90 minutes. As described in the next section, we study seven different resources (derived from [12] [18]) focusing in particular on what kind of resources configurations lead to responsible innovation.

RESOURCES NEEDED IN A GREEK ENVIRONMENTAL SME FOR RRI

Analytical framework

RBV's attention is focused on exploiting business resources so that it acquires a viable competitive advantage which allows for responsible innovation. However, by creating an "All inclusive" list of resources from which researches are being asked that can be framed is a daunting, if not impossible, task given that a plethora of conceptual definitions exist in the literature. Perhaps the main reason for the ambiguity is that the limits, components and resource definitions vary widely according to the perspective of interest of each group. In addition, modern accounting rules and standards helped a little to develop a definitive and strong categorization of resources other than those that are tangible and can be recorded in corporate accounts balance sheets.

Recognizing the lack of a standardized nomenclature, this study states a resource as a factor (at enterprise level) that can contribute financial benefits. Resources are broken down into two fundamental categories, tangible and intangible ones. Tangible resources include factors that contain economic or physical value, as measured by the balance sheet of the enterprise. Intangible resources, on the other hand, include factors that are not natural (or non-financial) and rarely, if ever, exist in the balance sheet of the enterprise. Surprisingly, although there is several systems' classification for intangible resources, almost no theoretical guidance has been offered to determine how intangible assets are classified or why they should be classified or categorized in any way. However, [23] [24] is one of the few authors to offer a method for identification of "how" and "why" could be classified as intangible resources.

Hall argues that intangible resources essentially fall into two categories, in assets and in skills (or capabilities). If the intangible resource is something that the business "has," it is an advantage. If the intangible resource is something the business "does", it is considered a skill. But the distinction between assets and capabilities may not be so easy to do [11]]. Anything else then, could be considered to be a skill. Of course, such guidance on asset-price discrimination capabilities is too simplified.

In fact, given the great conceptual scope of definitions in the literature, there seems to be a fine line as to whether a specific intangible resource is indeed an asset or a capacity. However, Hall's approach is adapted to that, so intangible resources are defined either as assets (what the enterprise owns) or as capabilities (what the business does).

Literature research on resources has led to the following four categories:

- The financial capital
- Skills
- Social capital
- Reputation

This typology is based on the resource categorization carried out by [18] [53]. It is worth noting that it contains fewer materials than all intangible resources. That is so because fist, intangible resources affect the company more than material [18] [53] and secondly, because they are more essential for start-up SMEs [27].

The selection of individual resource items is as follows. Some financial funds are usually required to implement an innovation. By dividing capital into equity and liabilities, we want to study whether the source of financial capital affects the creation of RI. Own funds contain any capital which does not include an amortization charge.

It is also contemplated whether skills of SMEs are a prerequisite for RI. Knowledge and intellectual property rights in industry were selected as specific proxy for capabilities (eg, [18]). Resource literature underlines the importance of networks and cooperation [13] [15] and was therefore elected as proxies for social capital.

In terms of reputation, both [18] and [26] highlight its importance as a resource that affects whether a business is able to acquire other resources (eg funds from external sources, networks). Based on the above, we end up categorizing resources as shown below.

<u>Financial capital</u>

1. Equity / Equity capitals

- Share Capital
- Reserves
- Sponsorship to the business

2. Liabilities

- Loans
- Credits from e.g. suppliers
- Customer advances

<u>Capabilities</u>

3. Industry knowledge

Knowledge of an SME is the experience of its employees, plans and procedures for its goods and services, its plans for future activities such as ideas for new products or services. The challenge is to exploit this knowledge in a coherent and productive way.

4. Intellectual Property Rights (IPR)

Intellectual property is an intangible asset of a business which protects it against the copying by competitors of e.g. innovation.

<u>Social capital</u>

5. Networks

The network, e.g. a company consists of

- customers
- suppliers
- distributors

- competitors
- universities or research centers
- financial institutions

6. Cooperation in the field of Research and Development (R&D Cooperation)

It concerns joint actions that are being developed, between a university and a company, leading to innovative ideas, products and services

Reputational assets

7. Reputation

Reputable assets may be the key elements for the company to gain positive impressions from its competitors, since they have to do with what the icon the public has formed for the company through the its products and its mode of operation.

CASE STUDY IN DIADYMA

In the present study, we used a detailed questionnaire for identifying the resources with which a company can form RI. The questionnaire is developed in 3 sections.

In the first section, RI is described briefly by this particular company (DIADYMA). Then they the form and type of innovation are captured as well as the number of people who worked for the SME.

In the second section, the distribution of financial capital sources is reflected. In particular, a table for identifying resources that were existing or were absent from the company is listed. Then, a series of questions on the origin of innovation financing follows (parent company, loan, state subsidy, venture capital or equity).

The third and final part refers to the resources. It analytically outlines how did the development of RI influence share capital, company reserves, grants, loans, third party credits and advances. It then reflects whether RI was new knowledge for the company and how this knowledge has differentiated a product-service and if it affected its competitiveness. It also mentions how RI has affected the company's relationships with their customers, distributors, competitors, universities, and others financial institutions and its co - operations in the field of research and development. Finally, the influence of RI on its reputation is described and how this reputation has affected its relationships with their customers, suppliers, the attraction of high-level officials and the local community.

Cases of Responsible Innovation

At this point we will refer to the innovation of DIADYMA and later on we compare the results with 2 companies, Parans, Think Global (already studied in Halme and Korpela). We present a detailed description of DIADYMA's innovation as well as the form, the type and number of workers who have worked for its realization.

DIADYMA, 1998

DIADYMA SA in the context of the development of recycling programs was the first inter-municipal enterprise in Greece that implemented the sorting system at the source of the waste using four different bins for the materials packaging. Specifically, while in the rest of Greece the collection and the temporary storage of recyclable materials is done in the blue bucket for all materials, in Western Macedonia, the collection is done in four different bins (based on the color of the lid) and in particular:

- Paper: In the bucket with the blue cap
- Plastic: In the bucket with the blue cap
- Glass: In the bucket with the yellow cap
- Metals: In the bucket with the red cap

Moreover, the system that was first introduced by DIADYMA SA, has been adopted by the National Waste Management Plan (NAP) for a few years to be followed by all agencies and municipalities in Greece.

Number of employees: 25

Social (S) or environmental (E) innovation: E

Type of Innovation: De (Design)

Table 1 below shows what resources each business owned (1) or not (0). We give in each resource a value of 1 when there is 0 and when it is absent from the innovation case. Later on, we use capitalization letter (A) for the existence of a resource and pedestrian for its absence (a). It seems that equity is the only necessary resource for responsible innovation. Below from equity (A), we classified the financial capital that did not require a refund.

Such funds could come from different sources: own funds of the owner, investment of the parent company, venture capital or state subsidy.

Table 1: Resources of small and medium-sized enterprises (1 = presence of a resource, 0 = absence of a resource)

Resource category / SME	Financial capital		Capabilities		Social capital		Reputational assets	Result
	Equity	Liabilities	Industry Knowledge	IPR	Networks	R&D cooperation	Reputation	Responsible innovation
DIADYMA	1	1	1	0	1	0	1	1
Parans	1	1	1	1	1	1	0	1
Think Global	1	0	0	0	0	1	1	1
No of SMEs	3/3	2/3	2/3	1/3	2/3	2/3	2/3	3/3

Table 2 shows that none of the innovations started with help only of investment or government subsidy. Moreover, only Think Global was funded by a parent company.

Table 2: Breakdown of financial capital resources in innovation cases.

SME	Own funds				Liabilities
	Financing by parent company	Self-financing	Venture capital investment	Government subsidy	Loan
DIADYMA		X		X	
Parans		X	X	X	X
Think Global	X		X	X	
No of SMEs	1/3	2/3	2/3	3/3	1/3

This parent company sponsored timely responsible development innovation. In addition, two companies received funding from venture capital funds. It is remarkable that all three were funded by the government of their country. Own funds were used by DIADYMA and Think Global (Table 2). Finally, only Parans took out a loan (table 2, Table 3).

The two sampled companies had access to research and development (R & D) (F, 2/3), which were representative of the social capital in this study. Only Parans had access to networks (E, 1/3). Their personal networks

entrepreneurs or business networks can be either individuals or groups, which provided a form of value to the SMEs.

Two types of capabilities examined here were the knowledge of the company (C) and Intellectual Property Rights (IPR) (D). It was considered that the company had industrial knowledge if at least one of its owners had a previous experience in the same industry. This applies to two SMEs. Commercially registered trademarks and patents were recorded as intellectual rights. Parans had patents.

Table 3: Types of innovation and combinations of resources in business cases. A capital letter indicates the existence of a resource while a small letter refers to its absence.

SME	Innovation Type	Existing resources	Non existing resources	Quantity of resources
DIADYMA	De	ABCG	def	Mean number of resources
Parans	Te	ABCDEF	g	Abundant
Think Global	Te/ BM/De	AFG	bcde	Scarce
Te: Technological innovation	A,a : Equity B,b: Liabilities C,c: Industry knowledge D,d: IPR E,e: Networks F,f: Cooperation for R&D G,g: Reputation			
De: Design innovation				
BM: Business model innovation				

For the purposes of this study, only the presence of reputation assets elements (G) in the development of innovation was considered to have designated as (1). By the time of the study, all companies in the sample had received awards or other forms of recognition for their responsible innovation. However, until then, innovation has already been created, and as we study innovation as a result, it would not be logical to include the reputation that emerged since the innovation was marketed. So, we are exploring the reputation ex-post, during the period in which innovation was in progress. On this basis, can be considered that innovations from two companies where benefited from a reputation asset. For example, the innovation of DIADYMA benefited from the company's good reputation.

As has been shown so far, responsible innovations in the sample are different in relation to the resources required for their creation. To look at this issue in detail, Table 3 illustrates the resources combinations behind responsible innovations of the case companies. A capital letter indicates the existence of a resource, while a lowercase letter refers to the absence of a resource. In other words, existing resources are marked as A, B, C, D, E and F, while a, b, c, d, e and f refer to missing resources. So, the capital letter corresponds to the value 1 and a small letter to the value 0 in Table 1. The combinations of these letters show the combinations of resources with which businesses have created a responsible innovation. Tables 1 and 3 are the basis for a further analysis.

We can find out from Table 3 that some businesses had access and used many types of resources to create a responsible innovation, while other responsible innovations have only a few resources as a background. Based on this, we have separated cases of responsible innovation in three categories:

1. Innovation with abundant resources (six or seven resources)

2. Innovation with an average resource (four or five resources)

3. Scarce innovation (one to three resources)

We think that an innovation does not have sufficient resources if it is only implemented with three resources or less. Innovations with four or five resources in the background represent the average price, while the abundance of innovations come from funds created with six resources (none of the companies had all the seven basic resources).

Instead of just making a comparison for resource combinations in the above static view, we want to look in more detail and describe in detail the combinations of resources needed to highlight RI in selected cases and what kind of dynamic relationships there are between resources.

Moreover, at the literature analysis it seems that resources have different roles in the implementation of an innovation. For example, some original resources make it possible to obtain others, thus implementing RI. This insight has led us to the concept of potential resource role, defined as part of the resource in the development of RI. The three emerging types of "dynamic role of resources' are as follows:

1. Igniting resources,
2. Realized resources,
3. Independent resources.

Igniting resource is a kind of energy resource, with which an enterprise may have access to another resource. For example, cooperation in R&D helps a business acquire reputational assets. A realized resource refers to a dependent resource that a business can develop with the help of an igniting resource. An independent resource is one that is not influenced by other resources and contributes directly to the creation of innovation.

INNOVATION WITH AVERAGE NUMBER OF RESOURCES - DIADYMA

The company is active in the operation and design of the IACS (Integrated Waste Management System) of Western Macedonia, in accordance with the 1995 Management Plan and was established in 1998. It manages the waste of the entire region of Western Macedonia. Since 2009, the collection has been gradually developed throughout the Region of recyclable waste in 4 different bins (paper, plastic, glass, metal) and not in a blue bucket, as is the case in the rest of the country based on official data of the CESR. The system that was first introduced by DIADYMA SA has been adopted by the National Design Waste Management (ECHR) in a few years to be followed by all agencies and municipalities in Greece. For the procurement of new bins, DIADYMA was funded by a state subsidy, while it was funded by equity for designing the above innovation. Finally, it is worth noting that this innovation has improved both reputation and networks (e.g. its relationship with the local society) of DIADYMA (Figure 4).

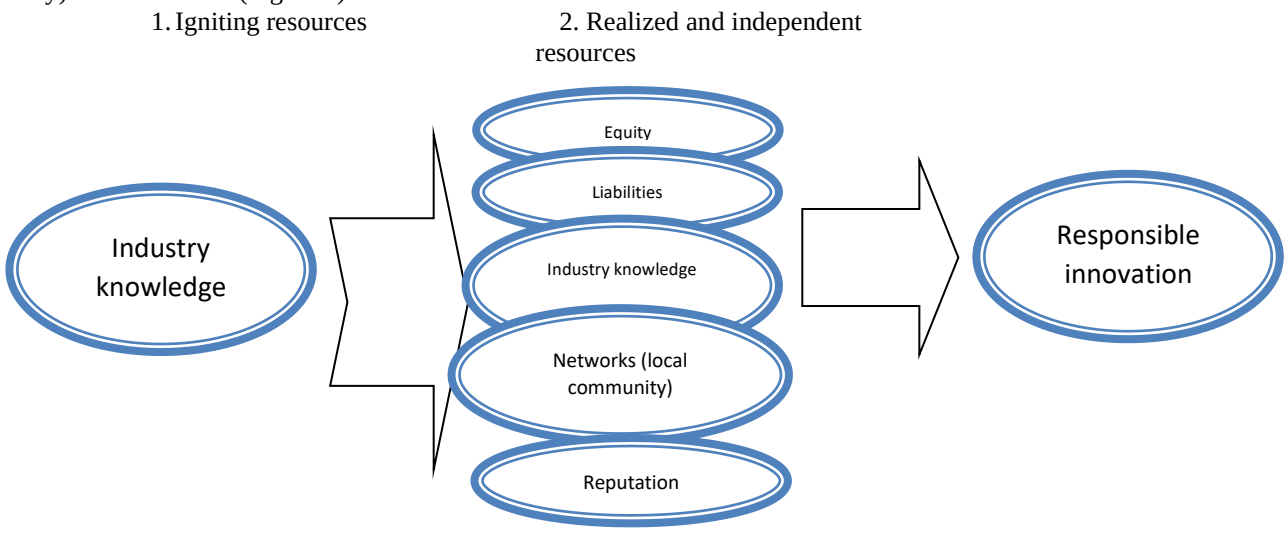

Figure 4: Resource patterns of DIADYMA

FINDINGS

The findings show that responsible innovations can be created with very different combinations of resources, both in terms of quantity and quality. This is quite important for resource-poor SMEs that need to develop RI. Innovation with scarce resources was created with only three types of resources, while the others used five and

six types of resources respectively. The financial capital in the form of own funds is considered a necessary resource to develop RI but is not a sufficient precondition for creating such innovations. It must be combined at least with social capital (R & D cooperation) in order to achieve RI. As indicated by the sample, the most common combination of resources consists of Equity, Liabilities, Industry Knowledge, Networks, Cooperation on R & D and Reputation.

Two of the companies, even those with insufficient resources, had the same funds of a financial nature in the form of equity and social capital in the form of R&D cooperation. Therefore, if RI is applied with only a few resources, equity and R & D cooperation seems to be the necessary resources. This is in line with the findings of Bos-Brouwers (2010) where some SMEs involved in sustainable innovation compensate for the lack of resources through cooperation with external partners. This observation shows that in the product development phase, working with customers or others relevant stakeholder groups makes it possible to acquire new ideas for the SMEs that do not have sufficient resources for their product or service. However, DIADYMA did not have any R&D cooperation, which shows that when there are many resources, some can offset R&D cooperation.

It seems that resource needs vary between types of innovation. Our sample was shaped by responsible innovations that were technological, design or business. Think Global, which is included in the category that does not have sufficient resources, with three types of resources, created one innovation that combines technology, design and business innovation standard. Technology-type innovation is related to the company that had abundant resources (the Parans). We can thus see that innovations of responsible business model can be created with resources from fewer than those required for technological innovation. Moreover, it is necessary to know the industry to obtain other resources, such as larger financial capital (business investment funds or subsidies), networks or assets of reputation, because without them technological innovations are unlikely to develop.

CONCLUSIONS

This study focuses on the resources behind responsible innovations of SMEs. The study shows that while lack of resources is a frequent barrier to responsible business practices in SMEs, specific types of sustainability can be implemented, such as business models responsible innovation even with limited resources. This finding has a significant practical impact on new potential entrepreneurs that have no resources, to reach responsible by offset the scarcity of resources with active R&D collaboration with clients and others (and will therefore have access to missing resources, e.g. through reputation).

Literature review reveals that public policies stimulating responsible innovation among SMEs can be a more productive approach for improvement in the environmental and social sectors instead of a simply promoting formal management of responsibilities. It is proposed that state funding should be directed towards RI. In our business sample all 3 innovations received government subsidies in their development, which obviously reflects the willingness of governments to encourage RI solutions to environmental and social problems. Moreover, we used qualitative comparative analysis (QCA) as an analysis technique to determine the logical conclusions the data sets of resources support. A limitation of the study is the fact that we only scrutinized seven resources behind responsible innovations, since our research is based on a former study already made for Nordic SMEs.

Recent years have been characterized by an increase of the sensitivity of citizens towards issues such as health, climate change and the environment, the degradation of the territories and the landscape, the loss of biodiversity, the consumption of natural resources, and the recovery of cultures and traditions of rural areas. These new sensibilities of the citizens have determined the conditions for the emergence, among other things, of new models of behavior for buying and food consumption, stimulating the search for new ways of creating value and sustainable development. Moreover, taking into consideration the economic recession in Greece, entrepreneurship is the best solution to foster social sustainability solutions. Through this study we shed some light for understanding how innovative entrepreneurs and SMEs acquire and utilize, sometimes even scarce, resources for sustainability aims.

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SMART FASHION: ATTRACTING WOMEN TO MECHATRONICS EDUCATION

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Abstract
There have been extensive studies that deal with the lack of females in STEM education, especially engineering. One of the approaches to attract more women to engineering is to bring technology to their everyday life. The women's desire for "being fashionable" and having a unique style daily, have motivated us to combine wearable electronics and fashion in order to bring mechatronics closer to young women. We have found an inspiration for design and manufacturing unique fashion accessories, giving the students the opportunity for personalized designs and the experience of being able to wear something they have created almost on their own. The engineering task to combine 3D printing with wearable electronics for fashion purposes is a challenge we believe will bring young women closer to advanced technology. The student program is an activity under a project supported by the National Innovation Fund.

Keywords
Gender; STEM education; Mechatronics; 3D printing; Fashion

1. Introduction

Raising awareness for STEM education and pursuing STEP careers has been global trend in the last decade. For young women showing that mechatronics can be fun and useful can be the first step towards interesting women in engineering education. The approach is different from traditional recruitment and promotion of engineering, because in this way, the applicability of mechatronics in everyday life is practically and directly presented in a unique and creative way.

The objectives of the program were to educate young women about industrial design, additive manufacturing and smart sensors, all introduced in the fashion industry. They will work in a team which will additionally develop their soft skill and raise their entrepreneurial spirit.

The mechatronics design is the backbone of this multidisciplinary approach. The students will not only get a fashion product, but also a trendy gadget.

The support of a company for the design of these accessories will bring the students closer to the real-life experiences. They will also finish with a fashion show presenting their results and increase their visibility.

The students will gain experiences in industrial design, additive manufacturing and smart sensors, all introduced in the fashion industry. They will show their skills and projects in dissemination events focusing on the fun and excitement of making something personal, encouraging young girls to choose engineering as a profession.

2. Additive manufacturing

3D printing is a process in which a realistic, physical object is created based on 3D design. It is also known as additive manufacturing, due to the fact that instead of removing material to create a particular product, it is a process of adding material in successive layers to create the desired shape [1].

3D printing is a relatively new technology that was introduced for the first time in 1986, but more serious attention was given to it in the late 1990s.

The main areas of 3D printing are:

- Prototyping

- Production of parts for specialized purposes in the military industry, biomedical engineering, dentistry, etc.
- Hobbies and home use
- Future purpose - medicine (parts of the body), buildings, cars.

3D printing uses software that builds 3D model in layers (0.01 mm thick or less, in most cases). Each layer is mapped to the build plate by the printer. Usual (traditional) manufacturing is known as subtractive manufacturing [2], since it represents the process of removing material from a pre-formed block. This type of production creates a lot of waste, because the material that is cut off can usually not be used for anything else. 3D printing eliminates such waste, since the material is built only in the required places.
The use of 3d printing in the fashion industry has increased dramatically in recent years. It is applied in the process of prototyping, designing, and even the production of fashion pieces. Since the beginning of 2010, 3D printing has become more accessible and offers the opportunity to experiment, find new solutions and innovate in fashion. Because additive production is still a new and underdeveloped technology, it is commonly used to create integral pieces with solid geometric shapes, and less for clothing and fashion accessories that have flexible features.
3D printing can significantly facilitate the creative process of designing and producing, because it allows to create shapes without moulds and that due to their high complexity could not be produced in a different way.

3D printing can be used to make ornaments that serve to enrich the creations traditionally produced by textiles. These ornaments have the function of "jewel". For this technique, a flexible TPU polymer or polyamide is commonly used. An innovative way of making ornaments using 3D printing technology is the PolyJet technique. Drops of high-quality resin are applied directly to the fabric, creating a smooth surface which immediately solidifies with UV light. This technique allows the production of 2d and 3d objects. Resin allows the design to have variations in colour and transparency.

3D printing plays a major role in minimize costs and save time for making products that contain metal or leather parts, because 3d printing uses as much material as needed to produce the product, without generating waste. This can be extremely important in the production of metal parts, because some metals that are used as material can be quite expensive.

The application of 3D printing in production of jewellery can be seen from two aspects: prototyping and direct production. Prototypes are used to make moulds and complex pieces, which will minimize costs and save time for making the final product. In direct production using the 3D print technology, the advantage is fast and efficiently producing small and simple parts and reduce the cost of stockpiling. Also, 3d printing enables quick and easy fulfilment of consumer preferences in terms of design, colour and size of jewellery.

A new and not sufficiently developed domain is the production of 3D printed watches, mainly for watch bands. The biggest advantage is fast respond to the customer's special requests like color, material, texture and design of the band.

A trend that is not yet reached the mass adoption stage is 3D printing of footwear. 3d printing can find application in meeting customer specific requirements in terms of product design, but also maximizing the performance of the shoes themselves.

The main advantages of the 3d printing in terms of the fashion industry are:

- Cost optimization – reduced costs due to simple and low-cost prototypes, reduced storage costs, absence of waste materials;
- Optimization of production and possibility for easier adjustment of production processes;
- Creation of complex forms;
- Adding modern technology to traditional manufacturing techniques.

Although the additive technology has its disadvantages, which are primarily seen in terms of the strength and functionality of the materials, it brings a new perspective and different shaping of the fashion industry.

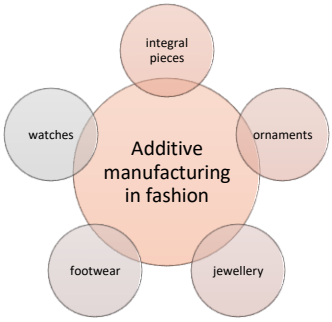

Figure 1 Additive manufacturing in fashion

3. Mechatronics devices

Mechatronics is a methodology for producing complex products that contain mechanical and electronic parts. Mechatronics unites the design of mechanical elements with electronics and control.

Features of mechatronic products are:

- functional interaction of mechanical, electronic and information technologies in one unit;
- intelligence associated with the control functions of the mechatronic system;
- adaptability that allows mechatronic products to adapt when changing tasks and environment;
- Multifunctionality which refers to the microprocessor functions determined by a computer program;
- Technological interdependence associated with available production technologies.

Mechatronics is not a fundamental, but an applied science. Applied science solves practical challenges using the knowledge of the fundamental science. In other words, applied science provides solutions that can be used to real-life situations.

The key elements of mechatronics (figure 2) are: sensors and actuators, physical system modelling, signals and systems, software and data acquisition, computers and logic systems [3].

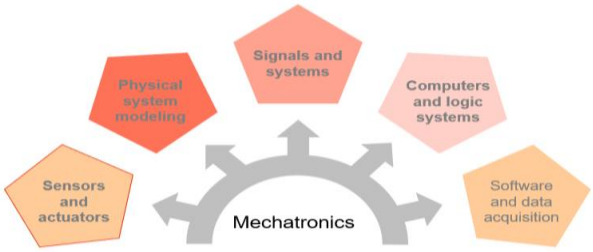

Figure 2 Key Elements of Mechatronics

Parts of the mechatronic system (figure 3) are: the structure, sensors, controllers and actuators.

Sensors are devices that detect a particular change in the environment and then convert that data in a format suitable for further processing.

The controller transmits data from the sensor to the control unit and from the control unit to the actuator.

The actuator is device that coverts electrical energy into mechanical and is responsible to produce movement.

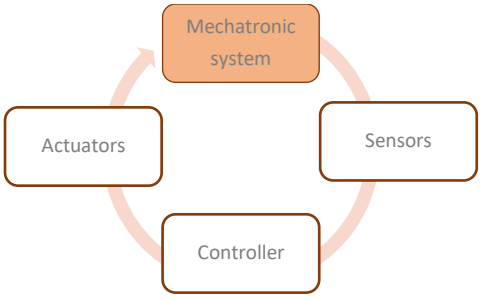

Figure 3 Parts of the mechatronic system

4. Case study

The PROJECT HUB is a centre with the main goal of establishing a connection between students, faculty and industry.

PROJECT HUB enables students to work on projects under the mentorship of the teaching staff, which are funded and logistically supported by the Faculty of Mechanical engineering. Altogether there are 10 projects and 46 students are involved, working on various innovative topics.
One of the projects most women students are interested in is smart fashion-wearable. The team consists of 4 female and 1 male students. The team focuses on making electronics that everyone can carry to themselves. Small electronic components placed in a nice design that is personalized for everyone's taste, 3D printable in order to fit everyone. Starting from children's designs with entertaining character for the smallest, to products that combine several devices and functions in one place, and with aesthetic appearance. What makes it combine two spheres, fashion and technology. The main motivation is today's trends of smart sneakers, clothes, eyeglasses, rings, which have various uses and functions.

Description of the project Wearables are smart devices (with micro controller) that can be integrated in clothing or jewellery. Wearables are smart electronic devices (electronic device with micro-controllers) that can be incorporated into clothing or worn on the body as implants or accessories. [4]. They have wide application in fashion, fashion accessories, health care, sports, as well as in the household. The main goal of this project is the smart mechatronic design of parts of clothing and fashion accessories with functional and / or decorative purpose. The project includes analytical modelling, CAD, finite-element method, optimization of the design and integration of compatible sensors, realization of functional prototypes and their promotion.

The objectives of the project are:

- Finite-element modelling
- Sensor analysis and their features
- CAD designs and 3D printing technology
- Integrating Smart Sensors into 3D printed designs.

The activities that were covered within the project are as follows:

1. Design and finite-element modelling. All designs of the rings, watches and glasses were modelled in SolidWorks.
2. Sensor analysis and their features. For the needs of the project, were used low-price sensors. Their functionality was tested. After seeing their advantages and disadvantages, a set of sensors was selected for integration into fashion accessories.
3. Printing designs using 3D print technology. Part of the selected designs were printed with Acrylonitrile Butadiene (ABS) which was created from acrylonitrile, butadiene and styrene polymers. The material is lightweight, has good strength, has excellent material properties and is wear-resistant. To print the rest of the designs, Polylactic Acid (PLA) was used which is biodegradable plastics from corn starch.
4. Integrating Smart Sensors into 3D Design Prints. Once the designs were printed using a 3D printer, the selected sensor sets were embedded in the respective pieces of jewellery and glasses.

The implementation of the project was in the period from October, 2018 until May, 2019.
According to the defined goals, the outcome that resulted from the project are the following:

- Defining the geometrical characteristics and developing a functional concept
- Examining the advantages and disadvantages of different types of sensors according to their purpose
- Proof of the concept through the preparation of a prototype and its analysis.
- Exhibition of final products.

Photos from the prototypes are shown in the pictures below (feature 4,5,6)

Figure 4 CAD designs of smart watches and 3D printed prototypes

Figure 5 CAD designs of smart glasses and 3D printed prototypes

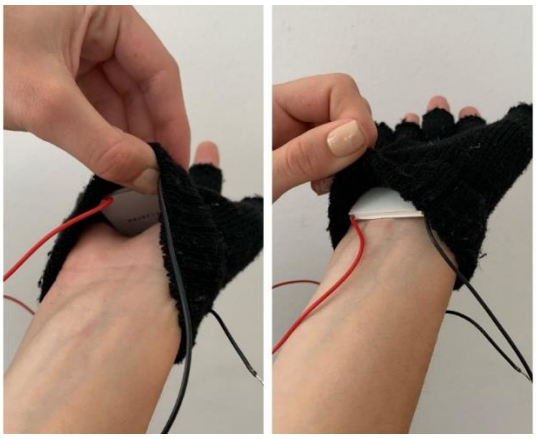

Figure 6 Smart gloves - Gloves that heat or cool with 3.7V battery

The results show that 46 participants have applied for Project Hub, of which 21 are female. Out of all 10 teams, there are at least 1 female member in 9 teams. Each team has a mentor, and out of 10 mentors, 5 are women. In the smart fashion team, 4 out of 5 members are female. At the final exhibition, number of young women who have not yet decided in which area they will build a career, have been invited. Through this it will be sent a message that engineering is not a predominantly male profession and that by including fashion, the mechatronics is an attractive area for study.

6. Conclusions

The findings of this study show that gender and program differentiation should be considered and points towards that there are creative ways to attract women to study mechatronics. The results of this study will be used to raise awareness that engineering is not a predominantly male profession. This will encourage young women to choose this profession more, and close the gender gap.

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DEVELOPING AN INTER-REGIONAL INNOVATION SYSTEM: A LONGITUDINAL APPROACH

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Abstract

This research studies collaboration among 15 triple helix institutions from four European regions with non-contiguous borders. It explores how inter-regional innovation systems are developed and establishes how institutions in regional institutional frameworks interact with each other at inter-regional level. The research employed a multiphase mixed methods research design, which entailed desk research (analysis of the four regions), a three time-point longitudinal survey (n=83), and interviews with the collaborative group (CG) (n=17), and a detailed review of 573 emails. The findings indicate that the inter-regional CG was working from the beginning and continued to collaborate effectively, despite their differences, throughout the collaborative process. The major contributions of this research includes a novel and unique framework for inter-regional innovation collaboration, which can be applied to regions and institutions that want to collaborate from a distance and across non-contiguous borders. The findings of this research also suggest that the inter-regional CG established an interaction and collaboration that works effectively over a distance and across non-contiguous borders. Additionally, the research identified the three non-spatial forms of proximity (social, cognitive and organisational) that are key determinants for developing a successful inter-regional innovation system.

Keywords

Collaboration, Inter-regional innovation system, longitudinal study, Triple Helix, Proximity.

1. Introduction

Collaboration across borders is often confined to a limited number of issues and it differs greatly in size, competences, finance and commitment [1]. While cross-border areas are believed to bring together firms, people and knowledge generation institutions that are in geographic proximity, albeit with an international border in between [2], [3] stated that the nation state border itself can act as a barrier to cross-border learning by hindering interaction between actors on both sides of the border. These barriers to cross-border collaboration can also be expected at inter-regional collaboration, especially with the absence of geographical proximity. While the systematic interaction between knowledge producer and knowledge exploitation sub-systems in regional innovation systems stresses the advantage of geographical proximity, this perception of spatial proximity as a competitive advantage raises the question of the possibility of creating an inter-regional innovation system (iRIS) with non-contiguous regions. In order to address this question, this research looked at collaboration among triple helix institutions in regions that do not share contiguous borders and explores how iRIS is developed.

2. Proximity and Inter-regional innovation system

While most innovation collaboration projects consist of partners who are located at close proximity and within organizational and cognitive boundaries [4] recent literature has explored the development of an innovation collaboration without spatial proximity. Although the systematic interaction between knowledge producer and knowledge exploitation sub-systems in regional innovation systems stresses the advantage of geographical proximity, the perception of spatial proximity as a competitive advantage raises the question of the possibility of creating inter-regional innovation collaboration with regions and institutions that are at a distance. To address this question, this research studies collaboration among 15 triple helix institutions from four European regions with non-contiguous borders. Hence, this paper presents a practical approach to developing inter-regional innovation collaboration by exploring a research in action '*e*DIGIREGION' project and establishes how institutions in regional institutional frameworks interact with each other at inter-regional level.

In an inter-regional collaboration, the advantages that cross-border regions have regarding geographical proximity are non-existent when it comes to collaborating from a distance. Geographical proximity has been regarded as advantageous for inter-organizational collaboration and innovation [5], [6], [7] as the possibilities of face-to-face interactions decreases coordination costs and facilitates the transfer of tacit knowledge. However, in inter-regional collaboration, transfer of tacit knowledge is often considered not to be possible from a distance. The local character and the perception of region as a locus of innovation has been emphasized in the innovation processes perceiving spatial proximity as a competitive advantage. Accordingly, certain studies [8], [9], [10], [11] have provided evidence of the advantages of being close to one another and that geographical distance can be an impediment to collaboration. However, these studies raise the question of the possibility of collaborating at a distance.

The barriers to cross-border collaboration can also be expected in an inter-regional collaboration, especially with the absence of geographical proximity. In order to tackle this, the current research also looked at substituting geographical proximity to that of a non-spatial one. The institutional aspect is prominent in defining a regional innovation system as these institutional infrastructures support innovation within the region [12]; therefore, the current research investigates the actors involved, specifically in triple helix institutions (government, academia and industry).

The different institutional settings of academia versus industry versus government actors can be a hurdle for interactions [13] especially when regions collaborate with different institutions across borders. The relevant norms and beliefs alter as well as the rules and regulations under which they interact. Therefore, this research explored different forms of proximity that could hinder the inter-regional collaboration. Accordingly, Four (4) European regions that collaborated at an inter-regional level were chosen as a medium to explore inter-regional innovation collaboration. The regions are, Bucharest-Ilfov, Romania, Castilla-La Mancha, Spain, Central Hungary, Hungary and South East Ireland, Ireland. These four regions collaborated in a European Commission FP7 funded project called *e*DIGIREGION.

3. Methods

This research employs a mixed method design wherein longitudinal surveys were administered throughout the collaboration process represented by fifteen collaborating triple helix institutions from four different European regions that do not share contiguous borders. The longitudinal data provided (see Figure1 for data collection flow chart) an understanding of the institutions on an inter-regional collaboration process and established an interaction that worked effectively over a distance. Furthermore, the Wilders Collaboration Factors Inventory (WCFI) survey findings were followed up by interviews to have a deeper and more in-depth understanding of what makes an iRIS work.

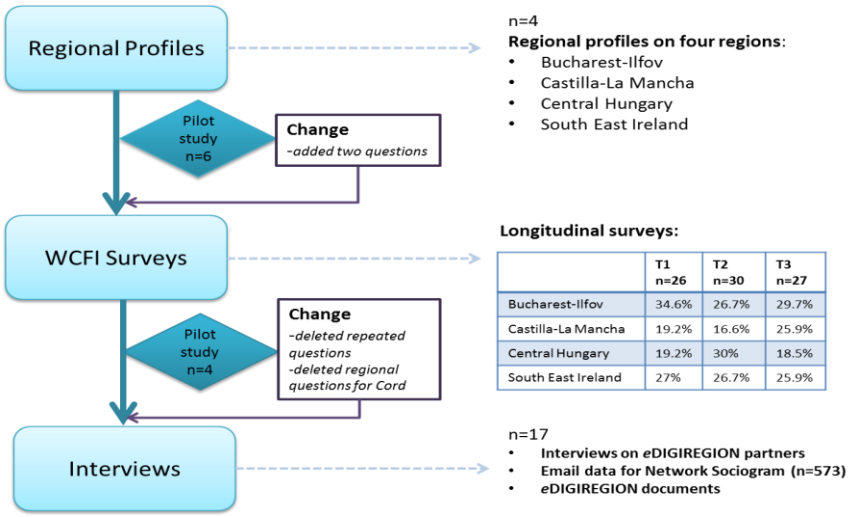

Figure 1 Data Collection Flow Chart ***(Source: Current research)***

Figure 1 shows the data collection flow chart for this research. Firstly, desk research was conducted on the four regions providing an understanding of their regional institutional frameworks. Secondly, a three-time point WCFI surveys were conducted with the *e*DIGIREGION partners. Finally, interviews were conducted with 17 *e*DIGIREGION partners, including the coordinator, four regional leaders and 12 triple helix representatives from each of the four regions. Access to the CG's Email communication data (n=573) was helpful in generating a Network Sociogram in order to show the communication links between the actors in the collaboration.

4. Results

The regional profiles of the four regions highlighted each region's settings and their capabilities in order to better understand how their frameworks influence collaboration at an inter-regional level. While the four regions have similarities such as the increasing trend of recovery after the economic crisis of 2008, these regions are still not at the level of competitiveness compared to that of the EU level. Accordingly, there is increasing funding from the EU towards regional collaboration to make peripheral regions more competitive. Therefore, this research aims to understand how regions that do not share borders can develop an inter-regional innovation system.

Secondly, the longitudinal data was collected at three (3) time-points using the Wilders Collaboration Factors Inventory (WCFI) tool. This tool was developed and validated by the Wilder Research Centre, which identified 20 factors that influence successful collaborations. All factors have been tested in multiple studies and are deemed generalisable by the researchers [14]. Accordingly, the Wilder Research Centre created a questionnaire designed to address the 20 factors with 40 Likert-scale style questions that investigate the details of organisations' actions related to collaboration and partnership. Overall, the findings from WCFI suggest that the institutions in different regions identify different favourable conditions at different points in time. At the start of their collaboration process, the members of the consortium believed that they had general public support regarding their collaborative group in their respective regions. However, it was shown that there are differences in perception between regions and an indication that there was statistically significant difference between South East Ireland and Castilla-La Mancha. This suggests that even though the CG as a group believed that they have the support for their CG objectives from policy makers and general public, there were differences in this perception among the collaborating regions. Furthermore, the findings indicate that the inter-regional CG was working from the beginning and continued to collaborate effectively, despite their differences, throughout the collaborative process.

Additionally, interviews were conducted (see Figure2) with seventeen *e*DIGIREGION partners which included the coordinator (n=1), the regional leads (n=4) in each region and the triple helix (TH) representatives were chosen at random from the represented institutions in the consortium (n=12). All the informants participated in the longitudinal survey (WCFI), which was conducted throughout the inter-regional collaboration process. The interview process allowed for greater understanding of the workings of the collaborative group (CG) at the inter-regional level and the identification of what makes the inter-regional collaboration (IRC) work from a distance. The findings uncovered that distance did not have a negative impact on the collaboration and that it is common among European projects to collaborate with regions that are not necessarily close to each other and are non-contiguous in nature. It was also found that distance did not impact the collaboration because of the type of collaboration the CG was in. The soft (policy) research involved in the collaboration did not require constant

face-to-face interaction while other types of collaboration that need constant face-to-face interaction and transfer of tacit knowledge could be impacted by the distance between the regions.

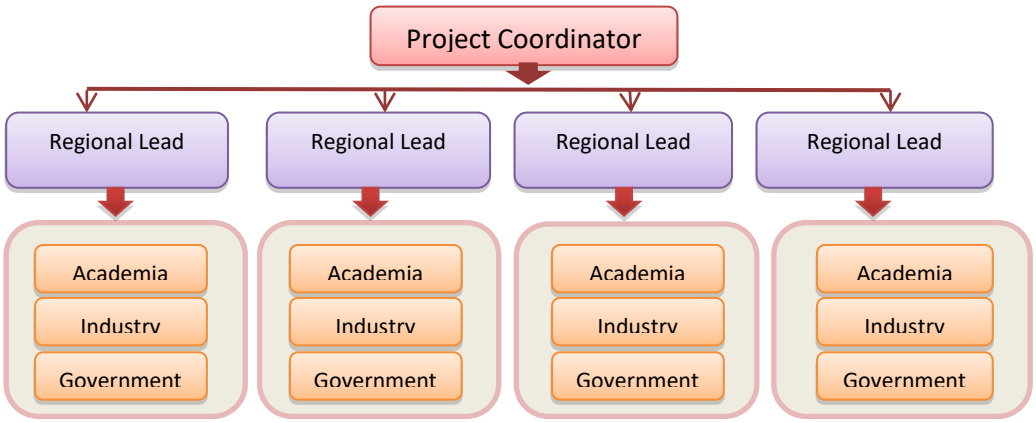

Figure 2 Key informants *(Source: Current research)*

The analysis uncovered differences such as culture, organisational and work culture. However, these differences did not hinder the collaboration as the informants felt it was a good opportunity to learn from each other and share knowledge not only regarding the project but the workings of each other's region. Even though interview questions addressed the frequency of the communication among the partners, from the coordinator and the regional lead partners, additional analysis was conducted through Network Sociogram by using the email data (n=573), which was collected throughout the collaborative process. The findings are consistent with the interview data, which suggests that there was open and frequent communication among the CG. Additionally, the differences in the systems of government were highlighted which impacts their policy making for the region. Most informants stated that engaging their regional government was challenging. Even though the triple helix collaboration in the four regions is not ideal, it is developing and by collaborating on an inter-regional level allowed them to learn from the other regions. Overall, the research suggested that even though there were many challenges and regional institutional frameworks are not ideal, the inter-regional collaboration worked because of three critical dimensions, namely, leadership and good management (organisational proximity), the relationships (social proximity) which existed among the CG partners, especially the informal relationships and their openness to learn and share knowledge with each other (cognitive proximity).

Even though the regional institutional frameworks in the current research did not hinder the development of iRIS, it should be considered when developing an iRIS as different regional institutional frameworks could vastly differ from each other, which could hinder the development of iRIS. Thus, based on the findings of the current research, a framework for inter-regional innovation system was developed (Figure 3).

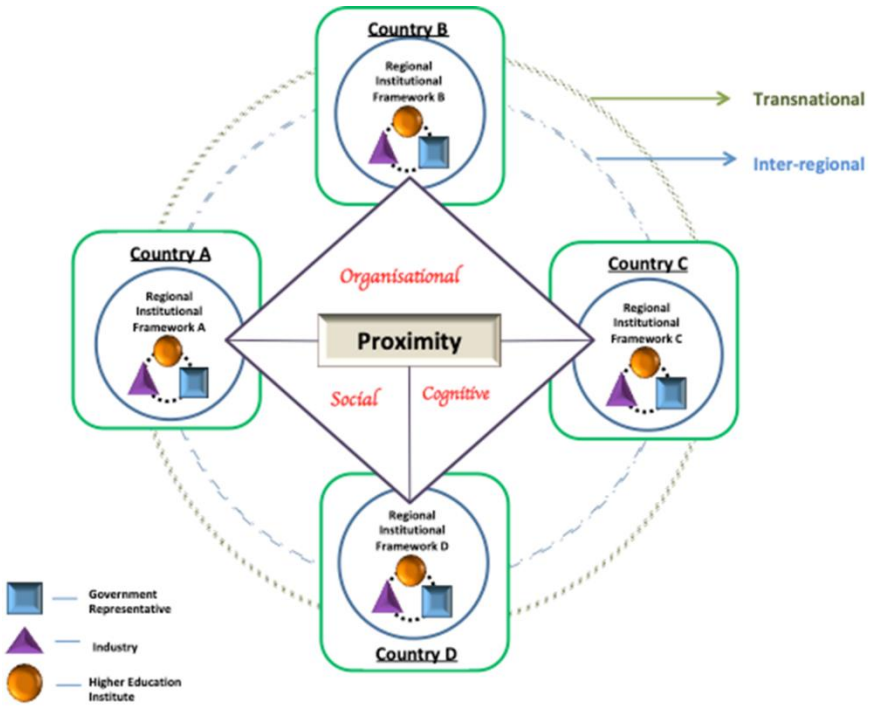

Figure 3 Inter-regional Innovation System Framework (*Source: Current Research*)

Figure 3 illustrates a framework for an inter-regional innovation system (iRIS) which shows four different regional institutional frameworks (A, B, C and D) which are within each country (A, B, C and D). It visualises the geographical distances and no two regions share borders or are in close proximity. The iRIS framework also highlights the three main forms of proximity (namely, cognitive, social and organisational) as integral to developing an inter-regional collaboration. In the *e*DIGIREGION collaborative innovation project where geographical proximity did not exist, the differences in institutions and cultures did not negatively influence the development of an inter-regional innovation system (iRIS). Rather, social, cognitive and organisational proximity played a vital role in the evolution of this iRIS. While cognitive proximity is considered a prerequisite for an interactive learning process to take place and can substitute geographical proximity, which can stimulate interaction over a long distance, it is not a sole dimension, which is required to develop an iRIS. Cognitive proximity is developed over time, which is evident from the longitudinal research, and it is complemented greatly by the existence of social proximity among the actors in the collaborative group (CG). Additionally, the current research also challenged the notion that too much proximity can be detrimental to learning and innovation as the evidence showed that the more the social proximity increased, cognitive proximity also increased which was a critical determinant for the success of the iRIS. Furthermore, leadership and management of the collaborative group also influenced the evolution of the iRIS where good coordination and clear structure and tasks were detrimental to achieve the objectives of the CG.

5. Conclusion

The current research is concerned with developing an inter-regional innovation system for regions that do not share borders. The focus of this research was on the dynamic actor-centric collaborative group, which comprised of different institutional types and from different regions and their influence on developing an inter-regional innovation system without the existence of geographical proximity. A multiphase mixed methods research design was employed with three different phases of data collection, including a three time point longitudinal data. Although the findings suggested differences in the regional institutional frameworks, it also acknowledged that as inter-regional collaboration progressed, the institutions involved got to know each other much better (creating both formal and informal relationships) therefore; these differences did not negatively impact on making their collaboration work. On the other hand, the differences in the rules and regulations of each institution were also highlighted (from a more bureaucratic institution like universities to a more flexible hierarchy of smaller companies where decision-making is easier). However, the informants emphasised the positive experience and the learning that they gained as a result of being exposed to the different working styles in the CG.

Based on the findings, the current research has major contributions to both theory and practice. Firstly, the notion that geographical proximity is advantageous for research and innovation activities and could be an impediment for interactions if it does not exist is addressed. The findings of this research suggest that the inter-regional CG

established an interaction and collaboration that works effectively over a distance and across non-contiguous borders. Secondly, the research identified the three non-spatial forms of proximity (social, cognitive and organisational) that are key determinants for developing successful inter-regional innovation collaboration. Thereby, the research suggests that the substitution mechanism of geographical proximity is not with only one non-spatial form of proximity but with all three non-spatial forms of proximities. Another major contribution of this research is the uniqueness of the study's method, especially the longitudinal aspect, employed to determine changes in perceptions of CG members over time. And finally, this study presents a novel and unique framework for inter-regional innovation collaboration, which can be applied to regions and institutions that want to collaborate from a distance and across non-contiguous borders.

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List of Abbreviations

CG- Collaborative group
IRC- Inter-regional Collaboration
iRIS- Inter-regional Innovation system
WCFI- Wilders Collaboration Factors Inventory

BARRIERS FOR RRI DIFFUSION IN LOW PERFORMANCE INNOVATION COUNTRIES: FINDINGS FROM THE "SPREADING EXCELLENCE AND WIDENING PARTICIPATION" H2020 PROGRAMME

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Abstract
The EC has promoted during last years a significant effort to promote and support the RRI paradigm across the whole Horizon 2020 program, mainly throughout the allocation of funding and dedicated calls to this concept. This determination has depicted an irregular expansion of the concept across the EU, in line with the member state´s organizations capacity and ability to capture funds from the research framework programme. In the case of the countries that entered the Union after 2004, this strategy has proven to be not so successful. In this contribution, the spread of RRI among low performance countries is explored in the "Widening" WP throughout documentation analysis and in liaison with 12 semi-structured interviews carried out to key informants. In the text, the authors argue that extending the values of the RRI paradigm to these countries will require systemic efforts for developing capacities and mechanisms that are not currently supported in these countries. However, these skills are critical to capture funds from the EU upon the increasing importance of the societal impact criterion of R&D.

Keywords
Science in society, innovation policies, RRI, smart specialization strategies, societal challenges.

1. Introduction

During the last decade, the EC has pushed an ambitious strategy to foster the embracement of Responsible Research and Innovation [from now on RRI] paradigm across the whole Horizon 2020 program [1,2]. This effort has helped to the establishment of a generous corpus of knowledge with significant experiences involving different institutions, organizations and individuals across the EU, for promoting a more open, democratic and participatory approach to research and innovation. However, this strategy has depicted an irregular expansion of the RRI paradigm across different member states, according to their national and contextual motivations, limitations and particularities [3]. Of special importance is the group of countries that are still lagging behind in the participation in research framework programmes [from now on RFP] which are currently not grasping the whole benefits of the European model of Research & Innovation [4,5]. This group of countries known as "Widening countries" or "Low-performance countries" [from now on LPC] are the recipients of a dedicated work programme [from now on WP] known as "Spreading Excellence and Widening Participation" [from now on SEWP] [6], that was set up in Horizon 2020 to meet this gap. In the next FP9, also known as "Horizon Europe" [7], it is expected that this subsection will gain importance for meeting the already existing divide in the European Research Area [from now on ERA] and current inequalities between territories.

In this contribution we analyze the findings of a diagnosis carried out in the SEWP WP, aimed to provide an understanding of what is the current status of RRI uptaking and awareness in this subsection of Horizon 2020 and their funded projects. This diagnosis has happened into the context of the New HoRRIzon [https://newhorrizon.eu/] project which has helped to provide a comprehensive diagnosis of the current status of RRI across all sections of Horizon 2020.

2. The push for RRI in a transition to socio-ethical awareness innovation ecosystems

In last years, the EC has promoted the adoption of the RRI paradigm through all the Horizon 2020 RFP [1,8–10]. Specifically, throughout the "Science with and for Society" WP [11], but not only, the EC have supported this idea throughout the provision and funding of several H2020 calls to be reached by different universities, research institutes, companies, public administrations, CSO´s and other stakeholders. This strategy has allowed to fund significant initiatives such as *RRI Tools* [https://www.rri-tools.eu], *MoRRI* [http://www.technopolis-group.com/morri/] or *FOTRISS* [http://fotrris-h2020.eu/] aimed to extend the benefits of the RRI paradigm across Europe and aligning the outputs of technological innovation and scientific research to societal concerns and expectations.

This premise is rooted in the current focus of the economic development agenda of the EC that has conferred innovation a central role for creating high-added value jobs, startups, patents and other kind of financial valuable returns [12]. This "innovation imperative" that can be observed in the policy making delivered by the Union is not exclusive of this part of the world, as different public administrations are trying to replicate successful innovation ecosystems that were originally developed in the US and have demonstrated their capacity to deliver these valuable financial outputs [13].

However, the importance that the EC has conferred in last years to the socio-ethical particularities of innovation can be seen as a commitment towards the own sustainability and accountability of regional innovation policies and the increasing complexity and difficulty for dealing with emerging societal challenges such as climate change, unemployment, inequality or migration. These challenges have outpaced techno-driven, techno-deterministic and techno-solutionism approaches, as well as they demand a reconfiguration of Research & Development [from now on R&D] models to make room for new kinds of innovations [14–16], but also for the development of scientific and technological knowledge in a more open, transparent and participatory way [17–20]. Of course RRI is not a disruptive paradigm, as previous paradigms such as ELSA [Ethical, Legal and Social Aspects of technology] or Technology Assessment have previously initiated this turn [21], but increasing societal concerns about R&D outputs, as well as moral backlashes that have surged in response to the digitization of industry are accelerating this transition [22].

Smart specialization strategies in Europe have been the cornerstone of regional innovation policy making since almost a decade, surging as a response to the productivity gap observed between the US and Europe, due to technological linkages and spillovers between sectors and regions [23]. That is one of the reasons that explain why these strategies are context-focused and rely on regional prioritization planning for facing challenges. Nevertheless, there is a growing need for smart specialization strategies as well as for Triple Helix and Quadruple Helix models [24,25] to be evolved for meeting these new societal demands and challenges at the forefront, and involving non present stakeholders in current regional innovation ecosystems.

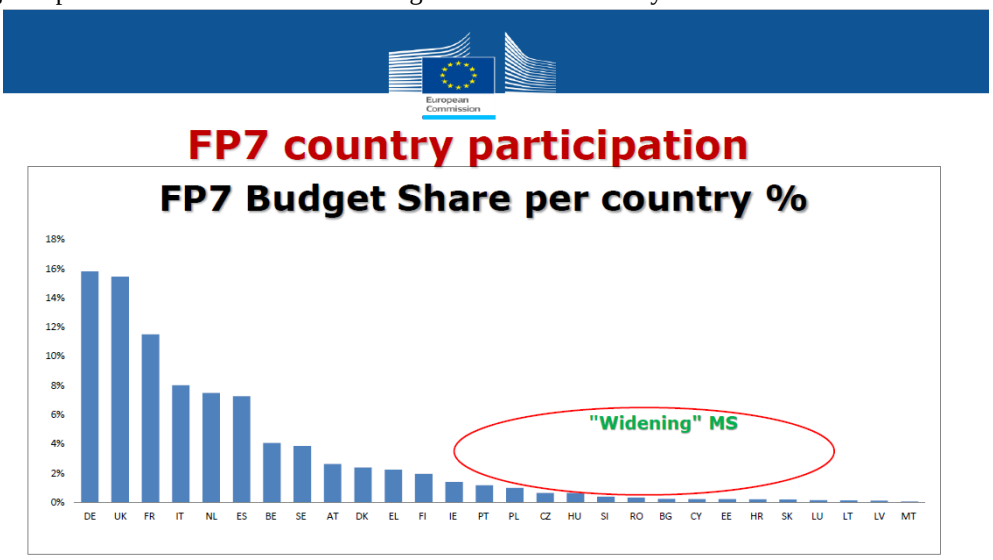

Figure 1 FP7 Budget share per country. Source [5]

Of particular importance in this transition of regional innovation policies for Europe is the group of countries that entered the union after 2004, with a low rate of participation in FP7 projects, and commonly known as LPC [5,6,26]. These member states were tackled as the recipients of specific actions oriented to promote their participation in the RFP for fully exploiting the potential of Europe´s talent pool and combining it with the European Structural and Investment funds [5,6]. In this sense, the diffusion of RRI in this group of countries is of outmost importance in the current policy cohesion that is promoted by the EC, for avoiding inequalities between regions and promoting the values of the R&D European model across the whole union. Moreover, assuring that investments in science and technology have positive economic effects in these countries but also are addressed to meet societal challenges and expectations requires an active involvement of society in scientific research and technology development for delivering the "right impacts" [17].

3. Methods

For analyzing the RRI uptaking and awareness of member states that are still lagging behind in their participation in EU RFPs, we pay attention to the SEWP Horizon 2020 WP [6]. The authors of this contribution have carried out a desk research of the main policy documents of interest related with this subsection of Horizon 2020 such as official WPs published by the EC, assessment reports produced by expert groups, policy recommendations delivered by independent experts and dedicated country reports. A documentation analysis [27] has been carried out for studying all these pieces of information and observing how the RRI paradigm and keys are introduced in the official WP and related documents.

Moreover, a bibliometric text-based search was also conducted for analyzing the presence of RRI keys [gender, governance, public engagement, ethics, open access, science education] into the abstracts of 123 projects funded under the SEWP Horizon 2020 subsection. However, this text analysis didn´t provided valuable information as

the keys were not mentioned but some elements of RRI were present in the abstract via other terminology or wording.

In addition, 12 semi-structured interviews have been carried out to several key informants, carefully selected between policy officers, project coordinators, project participants, national funding organizations, national contact points and other stakeholders that have a significant role in this WP. This method proved to be critical as it enabled to identify "RRI sensitive" projects that were not properly mapped out by the previous methods. Interviewees were coming from countries that are addressed in SEWP calls such as Bulgaria, Czech Republic, Greece, Poland, Portugal, Romania, Serbia or Ukraine and others that belong to the high-performance countries such as Austria or Spain. Interviews have been tape recorded and major findings have been transcribed. Due to geographical reasons, interviews were carried out mainly by teleconference systems. The duration of the interviews has oscillated from 25 to 45 minutes. No specific text analysis software has been used in the process. All participants have received an Informed Consent Form [ICF] for understanding project objectives, data collection and data treatment processes, and clarifications to the object of the study have been provided if needed.

The combination of these methods has allowed to elaborate a precise diagnosis of the current awareness and uptaking of the RRI paradigm in the WP, and also to inform the participants in the Social Lab [https://newhorrizon.eu/social-labs/] that is dedicated to this subsection and that is been held by the New HoRRIzon project.

4. The state of RRI in SEWP

After carrying out the research according to the previously methods exposed, several findings have emerged during the study. The lack of awareness about the RRI concept in Widening countries as well as its poor understanding and adoption has been highlighted by key informants and document analysis. Barriers for the diffusion of the RRI paradigm in these LPC are pretty much aligned with the difficulties for accessing Horizon 2020 funding. These difficulties respond to a variety of local problems that comprises a lack of national instruments and tools to support the competitiveness of their R&D organizations, as well as to empower researchers with skills and capabilities oriented to promote openness, responsiveness, transparency and engagement with and for society towards the aim of delivering societal impact.

These overarching findings are split up in dedicated points that follows: First, in most Widening countries the visibility of the RRI paradigm is limited, as well as it is poorly understood. Despite the EC has delivered some mentions to the term in the official SEWP WPs of the period 2016-17 and 2018-2020 [but not in 2014-15], there is a lack of awareness even among the members of the National Contact Point network. Some actions related to science education or public engagement have been highlighted by participants in the study regarding their home countries, but there is no formal recognition of the term or its keys.

Second, there are also several gaps among the countries that are part of this group, that it makes so difficult to provide a "one size fits all" solution. Some countries in the group are improving their positioning in R&D at the same time they are quite actively investing on it, while others are facing economic backlashes or are cutting the investment in R&D. These disparities also add a major complexity towards the diffusion of RRI throughout the SEWP WP. Something that was also stressed during the interviews. Third, there is a combination of no national actions or instruments oriented to tackling societal challenges as well as a lack of responsiveness culture towards societal demands. This explains in part the lack of skills and capacities in this field from organizations and researchers, but it clearly rises as a great disadvantage for capturing European funds that are allocated throughout societal impact as an important criterion in an ex-ante evaluation [26].

Fourth, deliberative approaches in governance apparatuses of R&D centers are not widely used as well as accountability mechanisms towards society are not properly developed. The key informants involved in the study belong to many scientific institutions or technological institutes that didn´t have these kinds of assets. Last, there is a lack of synergies with EU RRI funded projects coordinated by institutions that belong to HPCs that might act as facilitators of the RRI paradigm in these countries. This could be used as a mitigation measure in order to maximize the impact of the funds allocated and trying to establish some kind of bridges in transversal issues that are at the core of this transformation of regional innovation policy making.

5. Discussion and concluding remarks

During this contribution we have tried to expose the limited visibility of the RRI paradigm in the countries that are the recipients of the SEWP WP. As we have stressed, their low participation in the ERA is still a big barrier to benefit from the economic development agenda based on innovation that is promoted by the EC. In this sense, RRI paradigm can be seen as an opportunity for them to catching up with the values that are promoted by and increasing their competitiveness for capturing EU funds and delivering technological innovations aligned to societal expectations. In this view, RRI can be a social innovation that can transform the entire systems of R&D at regional levels providing new opportunities to engage society in science and technology [18].

However, this transition to a more open, transparent, participatory, responsive and socially engaged innovation ecosystems needs of significant efforts from a national point of view. That is why increasing the allocation of funds to SEWP in next Horizon Europe[7] seems to be a measure aimed to correct this gap in participation, but

it also seems to be not enough to address the problem. This solution implies to put the cart before the horse and not tackling the root of the problem, which lies in socio-economic and cultural reasons that prevent involvement and engagement of society in science, technology and innovation [26].

In this sense, we can argue that if RRI is considered a major priority for the EC in the development of an internationally recognized and distinctive model of R&I, this push towards RRI must be extended further away from the scope of competitive Horizon 2020 calls. The values that are at the core of RRI can be recognized as some of the values present in a small number of particular member states that have been taken up by the EC, and later on, expanded to the rest of the Union through the funding of collaborative research projects [10].

Of course, this has proven to be successful in many of the countries where institutions, organizations and researchers have engaged with the RRI paradigm, and have benefited from their participation in these Horizon 2020 calls [3]. However, an effort to extend this paradigm throughout other means to the LPC countries is necessary for meeting the gap with this group. Measures oriented to the use of structural and investment funds, the alignment of national policies to facilitate this transition to societal impact of R&D ecosystems or establishing bridges between programs like SWAFS and SEWP are of critical importance. Missing capacities and skills, as well as other problems that are rooted in socio-economic and cultural frameworks won´t be solved in the short-term if specific actions to facilitate this transition are not delivered, within a reformed RFP domain or outside the RFP domain.

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Abbreviations
EC: European Commission
ERA: European Research Area
EU: European Union
RFP: Research Framework programme
HPC: High performance country
LPC: Low performance country
SEWP: Spreading Excellence & Widening Participation
R&D: Research & development
RRI: Responsible Research & Innovation
WP: Work Programme

FACTORS AFFECTING MILLENNIALS' KNOWLEDGE SHARING IN THE INFORMATION TECHNOLOGY SECTOR: A STRUCTURAL EQUATION MODEL APPROACH

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Abstract

In modern Information Technology (IT) competitive environment, there are lots of strengths and exploitable opportunities in creating a functional knowledge sharing environment. In order to create a functional knowledge sharing environment, the organisation should find the right balance between theory and practice. Millennials, as the majority of employees in the software development companies, do act as members of the team. The aim of the research is to recognize how the factors (Trust, Employee Relationship, Motivation to share, Organizational Culture and Formalization) influence Millennials' knowledge sharing attitude, and how they can be utilized to support their intention to create an organizational knowledge sharing environment. All the factors (Trust, Employee Relationship, Motivation to share, Organizational Culture, Formalization) have been found to affect both Knowledge sharing attitude and Intention to create knowledge sharing environment. In this study, all the aforementioned factors are incorporated into a single model by processing data from small and medium-sized enterprises. Overall, the final model can explain 60 percent of the factor's Intention to create knowledge sharing environment variance.

Keywords

Information Technology, Knowledge Sharing, Millennials, Structural Equation Modelling

1. Introduction

Millennials behave differently inside organizations and management needs to manage their manners and knowledge gaining and sharing distinctiveness. Each company can utilize these tools to create an environment that separates the ones that are willing to gain knowledge against the ones they don't in the quickest way possible. To make that happen the organizations need to find the factors and create a knowledge sharing environment. The software products are becoming an important and necessary part of every organization. IT sector and its products are advancing in creating more practical and helpful solutions for scientific and sophisticated matters. That is why the project's success depends on the incorporation of the different skills, ideas, thinking, creating knowledge practices and the ability of the organization to adapt and become more creative. [1] stated software development companies have an issue with intellectual capital in a way that they are not consistent. Due to the fact that Millennials nowadays are changing too often software development workplace, their knowledge gaining and sharing habits are essential in creating a successful knowledge sharing environment. In modern IT competitive environment there are lots of strengths and exploitable opportunities in creating functional knowledge sharing environment. In order for such an environment to be created, management should follow the dual approach to the production of knowledge [2] by making the right balance between theory and practice.

2. Literature review

Figure 1 demonstrates the proposed research model, where the relations between the factors appear.

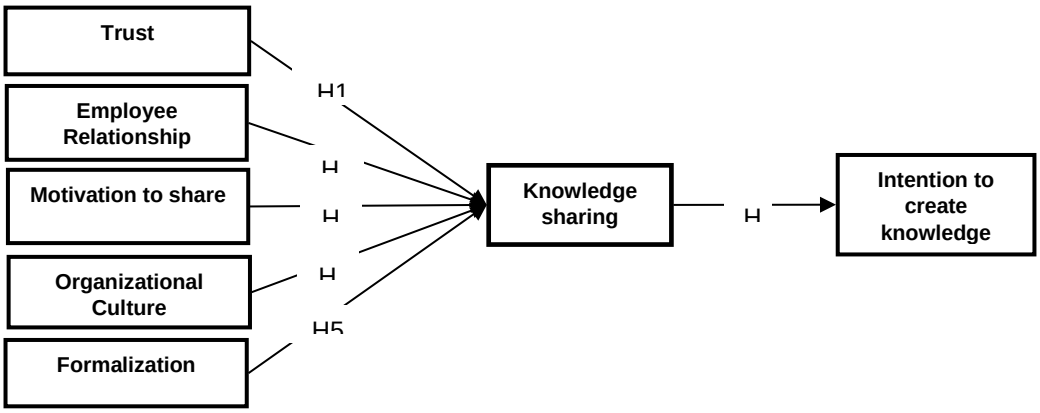

Figure 1 Proposed research model.

2.1 Trust and knowledge sharing attitude

[3] state that trust is essential for creating and exchanging knowledge, explaining that it should exist between peer to workers and between the workers and the management. The positive relation between trust and knowledge sharing can be found in many studies. [4] and [5] in their studies found that interpersonal trust among team members influences the extent of knowledge sharing. Also [6], [7] and [8] bring in trust as an important affecter to knowledge sharing. Employees' are more willing to share their knowledge if the trust is founded in the company. [9] argue that without trust there is no meaning of knowledge sharing and refers to trust as a critical influencing factor in creating a knowledge sharing environment. Also [10], [11], [12], [13], and [14] consider trust as a crucial supporter of knowledge sharing. Based on the above, the following hypothesis is proposed:

H1.Trust among employees will positively affect Millennials knowledge sharing attitude.

2.2 Employee Relationship and knowledge sharing attitude

[15] imply that It is essential that the employees perform together as a collective unit and contribute equally to the realization of a common goal. Employees must tend to act like a group of individuals, but in a way to fulfill the outcome and bring the company's achievement, both higher in rank and in profit too. Millennials tend to have an interesting approach in solving everyday problems, positive energy, optimism and trust that the outcome at the end would be as perfect as well. [15] and [16] studies show that knowledge sharing is influenced by the social relationship. [17] showed that a social relationship is well connected with a favorable attitude towards knowledge sharing. In every company, it is widespread for employees to create links and friendships with others. Creating a positive relationship between co-workers would be more positive in sharing their knowledge, ideas and thoughts. Also [17] state, positive relations between co-workers affect positively knowledge sharing attitude, thus the following hypothesis can be proposed:

H2. Employees Relationship will positively affect knowledge sharing attitude.

2.3 Motivation and knowledge sharing attitude

[18] also argue that knowledge is defined as a mixture, a blend of experiences, personal skills and perceptions, and the ability to translate them correctly and completely. This certainly implies synergy between employees in sharing knowledge as well as solving key tasks. As [19] imply Millennials love freedom, openness to new ideas, accept differences and are truly rebellious when working under pressure in a non-indefinite environment that tears them, and which does not allow their creativity to come to the surface. The Millennials prefer a relaxed working atmosphere with appropriate working conditions, which allow for pleasantness, and free movement [19]. Hence, it can be stated that motivation is important to them, even crucial in creating their business ability, as well as accepting new challenges. Therefore, the following hypothesis is proposed:

H3. Motivation will positively affect Millennials knowledge sharing attitude

2.4 Organizational culture and knowledge sharing attitude

[20] investigated organizational culture and multicultural differences and its effects on the knowledge sharing attitudes. [21] in their research found that organizational culture influence tacit knowledge sharing behavior and those influences may be positive or negative depending on the culture type. Moreover, [22] study shows that Knowledge sharing culture is accepted as a variable that has to be badly taken in concern when people are interacting in social networks. Social network as communication in organizational culture is fundamental in encouraging knowledge transfer [23]. Also [24] took into consideration the communication climate as a factor of organizational culture. In his study, he argues that organizations which give confidence to communication and exchange of information results in a positive attitude towards sharing knowledge. Opposite of that in organizations with suspicious communication climates, employees keep things to themselves and make only cautious statements, as [25] stated. Thus, it is hypothesized that:

H4. Organizational culture will positively affect Millennials knowledge sharing attitude.

2.5 Formalization and knowledge sharing attitude

Exterminating the formalization [11], believe that it has somehow negative impact on knowledge sharing. According to [3] formalization as a word means a strict set of rules and follow up steps that determents relationship within the organization. For the Millennials, it is important to note that they strive for informal, more liberal and free structures [26]. Millennials want a close relationship with the collective, cooperation and trust. Workforce is marginalized, they are not given responsibilities, i.e. Subordinates cannot participate in the decision-making process as well as to influence in any way the key issues that each individual is concerned about [27], [28]. The enormous negativity of this model of organizational structure is that Millenniums are easily stinging in apathy, pattern and repetitions that quickly become saturated, and thus less motivated to give a maximum, to exchange experiences, skills and knowledge with other employees. So, it can be hypotheses that:

H5. The formalization will negatively affect Millennials knowledge sharing attitude

2.6 Knowledge sharing attitude and intention to create knowledge sharing environment

[29] argues that a positive knowledge sharing attitude will lead to positive behavior towards knowledge sharing. [30] confirm that attitude is a strong interpreter of behavioral intention. Thus, it is acceptable to believe the more positive attitude toward knowledge sharing is the more intention of involving in knowledge sharing. [31] had claimed that knowledge sharing attitude is a significant predictor of intention to engage in those actions. Also, they argued that intention to share knowledge is determined by a person's attitude towards knowledge sharing. The attitude towards knowledge sharing according to [17] is defined as the degree of one's positive feelings about sharing knowledge. This leads to [32] argument that people believe that they could improve their relationship with others by offering their knowledge and expertise. People believe that by doing so, they would increase a more positive knowledge sharing attitude that will create a better organizational environment. This analysis leads to the hypothesis:

H6. Millennials knowledge sharing attitude will positively affect intention to create a knowledge sharing environment

Table 1 Research factors.

Factor	Definition	Items	References
Trust	The extent to which a person is confident in, and willing to act based on, the words, actions and decisions of another.	5	10,11,12,13,14
Employee Relationship	The degree of community ties that will provide important environmental conditions for knowledge exchange	4	15,34
Motivation to share	The degree of motivation in the context of knowledge sharing that arises from the expected results of participating in knowledge sharing	5	20,11
Formalization	The degree in which organizational are clear in written documents regarding procedures, job descriptions, regulations on employee's knowledge sharing.	6	11,3
Organizational Culture	The degree in which people deal with a pattern of behavior based on the organizational culture.	4	35,20
Knowledge sharing attitudes	The degree of employee's favorable or positive feeling about sharing his/her knowledge.	5	11,36,37
Intention to create knowledge sharing environment	The degree of employee's intention to defuse his/her job-related knowhow and experiences in the organizational environment.	6	10

3. Research Methodology

This research followed the quantitative research approach. A structured questionnaire was used to collect the needed data. From the 400 questionnaires, 193 were adequately completed (valid sample). The following tables 2 and 3 present the descriptive statistics and factors' validity and reliability, respectively, while Figure 2 the extracted research model.

Table 2 Descriptive statistics

		Statistics			
Participant characteristics	Age	18-25:	12.6%	31-35:	47.1%
		26-30:	18.4%	>35	21.9%
	Sex	Male:	64.3%	Female:	35.7%
	Education	Postgraduate:	22.6%	High school:	18.7%
		Undergraduate	46.5%	Other:	12.2%
	Marital status	Single:	57.1%	Married:	42.9%
	Job position	Manager:	5.2%	Employee:	85.5%
		Supervisor	9.3%		
	Job Experience (in years)	<5:	32.3%	>10:	17.4%
		6-10:	50.3%		
	Company size	1-25	42.4%	>49	20.9%
		26-49	36.7%		

Note: Sample size, N=193

Table 3 Factor validity and reliabilty

Factor	Statistics	Items	Loadings
Trust	K.M.O.=.750 / Bartlett's Sig=.000 TVE=65.391 / Cronbach α=.863	5	0.723-0.924
Employee relationship	K.M.O.=.724 / Bartlett's Sig=.000 TVE=63.246 / Cronbach α=.787	4	0.666-0.904
Motivation to share	K.M.O.=.790 / Bartlett's Sig=.000 TVE=68.565 / Cronbach α=.845	4 (5)	0.807-0.856
Organizational culture	K.M.O.=.679 / Bartlett's Sig=.000 TVE=76.049 / Cronbach α=835	3(4)	0.827-0.919

Formalization	K.M.O.=.500 / Bartlett's Sig=.000 TVE=85.463 / Cronbach α=.828	2(6)	0.924-0.924
Intention	K.M.O.=.857 / Bartlett's Sig=.000 TVE=69.151 //Cronbach α=.909	6	0.769 -0.889
Knowledge sharing attitude	K.M.O.=.681 / Bartlett's Sig=.000 TVE=54.266 / Cronbach α=.912	5	0.746 -0.917

4. Conclusions and Managerial Implications

Trust among employees is one of the most important factors that affect knowledge sharing behaviour in an IT company. This finding is reliable with previous works [10], [11],[12], [6], [7], and [5]. Supporting this hypothesis in the study also indicates that Millennials enjoy working in a workplace environment where they can feel free to interact and share ideas related to the work. If the Millennials are motivated and have a sense of belonging in the company, they will share their knowledge without hesitation. Even if Millennials have trust and good personal relations between them, if they are not motivated their enthusiasm to share knowledge cannot be extracted and the company will not benefit. So, it is of great importance for the company to create motivational programs in order to encourage them to transfer the critical working information. The results of the study also correspondent with previous studies [20], [11], [38]. If Millennials operate in surroundings with good organizational culture can share their knowledge without hesitation. The study correspondent with previous studies (34) and (20) that support the hypothesis that organizational culture is one of the factors that have a positive influence in attitude to share knowledge. All organizations have characters as individuals do and characteristics as openness, flexibility, values, beliefs, and more. That is why the individuals in the organization deal with a particular model of behavior based on the culture of the organization. Formalization has a negative impact on knowledge sharing attitude. The result indicates that the company should focus on flexible structure and procedures in order to accomplish the benefits of knowledge sharing practices. The result also confirms previous studies [27], [28] about Millennials traits about their desire for collaboration, team-based projects and an unstructured flow of information at all levels. [3] highlighted that a mixture of a formal structure and a non-hierarchical, self-organizing formation would develop knowledge creation and sharing practices.

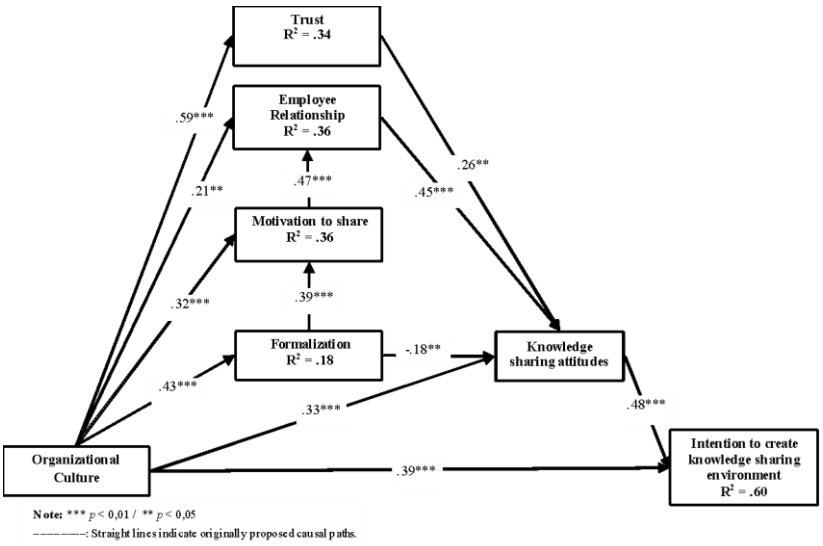

Figure 2 Research structural model

Managers in the IT sector would realize that harvesting Millennials knowledge brings welfares for them and it will improve the overall job performance. But on the other side, managing the Millennials intellectual capital is challenging to operate, because Millennials personal believes of implementing knowledge sharing practices, might affect their attitude to adopt the model. Executives need to understand that having the right knowledge and creating the organizational ability to share it is a strategic tool. The study brings to attention that investing in technology and processes is not enough for the company. Managers should invest and take care of their essential knowledge sharing tool –workforce these days Millennials. The study also presents support for managers in the implementation of a right knowledge management strategy to get better organizational performance and innovations to the company. The knowledge of the managers and the benefits of implementing knowledge management strategy and understanding the factors that influence it can make them more effective and charismatic. The managers will know how to get the most from Millennials and make them gain and share the knowledge, which will lead to new innovations and better organizational practices.

4.1 Research limitations and suggestions for future research

A possible limitation of this study is that according to [39] there are many subcultures within national culture, thus identifying them will help future researchers to extract helpful conclusions. In addition, another possible limitation is that the impact on using organisational knowledge sharing platforms is not examined, thus future researchers may incorporate this factor to future research models.

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UNIVERSITY'S ORGANIZATIONAL CULTURE AS A FACTOR OF ACADEMIC ENTREPRENEURSHIP

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Modern universities include academic entrepreneurship into their primary goals.

Keywords
Entrepreneurial Ecosystems, Triple Helix Concept, University Spin-offs

1. Introduction

There is no doubt that for the last decades, modern universities have been exposed to dramatic changes in their role in social and economic progress. Accelerating technology development affects all the elements of the society, including higher education institutions. The necessity of universities taking an active part in technology transfer comes from the idea that future economic growth can be achieved only through close interaction between three main actors: state authorities, business community and universities. This framework is widely known as Triple helix concept and was initially developed by H. Etzkowitz and L. Leydesdorff [1].

Academic entrepreneurship is a term referred to mechanism through which universities participate in Triple helix interactions. Namely, it is an activity of universities transferring their intellectual capital into practice, i.e. commercialize it [2]. Usually, this process takes forms of creating SMEs by students and faculty members (university spin-offs), scientific research for and together with business, licensing of university's technologies, faculty mobility, unformal contacts between scientists, etc. [3].

The formation of Triple helix cannot be reached instantaneously in a country or a region, it moves through the number of stages and has its peculiarities in different national systems (educational, innovation, legislative, etc.).

It is a widely shared opinion that in Russia the concept of Triple helix is still far from being fully implemented. Firstly, the Russian government excessively plays the leading role in university–business–state relationships. Secondly, Russian universities value their traditional functions (education and research) above other activities, including academic entrepreneurship. Obviously, there is a number of reasons for that, most of them stem from the past. The main reason is lack of decent entrepreneurial experience, since business practices of the 1990s created distaste in the society for being an entrepreneur. Another reason is the division between higher education institutions and scientific organizations in the Soviet Union occurred in the sphere of R&D. Universities were engaged in complex scientific research projects only occasionally. Nevertheless, the situation changes and plenty of Russian universities have started introducing entrepreneurial principles. They need to not only introduce new policies and create new departments, but also to alter the perception of entrepreneurship.

2. The essence of university's organizational culture

2.1 Components of entrepreneurial system in university

According to the modern approach, academic entrepreneurship implementation is closely connected with creating of a specific entrepreneurial ecosystem. Such an ecosystem combines:

- tangible components: university's departments and formal policies, complementary facilities, researchers, entrepreneurs, experts, entrepreneurship training courses, etc.;
- intangible components: informal networking connections, shared values and mindsets - in other words, organizational culture or organizational climate.

The intangible components' impact on academic entrepreneurship development is often underestimated by university's administration. Yet, paying attention only to tangible components does not provide enough momentum to such development. Thus, the specific actions aimed at transforming organizational culture should be included into university's administration agenda.

2.2 Importance

We share the view that a proper organizational culture of university is one of the vital components for developing of academic entrepreneurship in it. In 1998, Clark claimed that a higher education institution trying to execute successful transformation into entrepreneurial university must develop special entrepreneurial culture [4]. In addition, strong evidence has been found, for example, among Swedish and German universities that emphasizing academic entrepreneurship as an important element of university's activity and the presence of entrepreneurial role models increase entrepreneurial intentions in that university [5].

In this paper, the attention is paid mostly to a specific form of academic entrepreneurship – creating start-ups. Even though, licensing and joint research provide incomes much earlier, it is new small innovative business that can greatly contribute to economic development in the region or country in the future. Another reason is that entrepreneurship involves wider range of specialists and experts, which enriches university ecosystem.

Organizational culture can form the specific support for entrepreneurs. It is especially crucial for entrepreneurs in Russia, since in this country, entrepreneurship has been prohibited for decades in the 20th century and this activity is still regarded as highly risky. Up to now, Global Entrepreneurship Monitor (GEM) research results show that in Russia fear of failure rate (46.4%) considerably exceeds global and regional average (36.2% and 38.9% respectively) [6]. Moreover, Russian legislation and taxation systems are perceived as excessively complicated and vague. Under these circumstances, nascent entrepreneurs are in great need for support.

Obviously, the first stage of changing university's organizational culture should be its assessment. The general goal of that is to understand whether organizational culture contributes to academic entrepreneurship or hamper it. The main form of the assessment is opinion surveys. There are some aspects that can be examined:

- attitude towards entrepreneurship in general;
- aspirations to start business and factors influencing them;
- eagerness to participate in academic entrepreneurial projects;
- support measures needed;
- obstacles to starting business.

The next part of the paper is devoted to such research conducted by the author.

3. Research of university's organizational culture

3.1 Description of the research

In this paper, we discuss only a part of university organizational culture, namely aspirations of students and faculty members with respect to potential business creation and their expectations towards university's support. In order to assess those sides, the research was started by the author in 2015. The study was carried out in 2 stages: during the first stage students' survey was conducted, the second survey was aimed at faculty members. The respondents of the first stage were the students of bachelor and master programs, predominantly with major in economics. They study in universities that are situated in St. Petersburg, Russia. Most answers were obtained from St. Petersburg State University (SPbU). That university is one of the oldest and biggest universities in Russia, and it combines Scientific Departments and Schools of various fields: mathematics, physics, chemistry, management, economics, philology, psychology, etc. SPbU is considered more as traditional state university: 80.5% of its funding comes from the federal government budget, only 16% – income from R&D [7]. Though innovation activity support is included into the Strategy of SPbU along with development of educational practices and research, so far there are not so many specific actions towards academic entrepreneurship development. According to Interfax Agency, SPbU is No. 16 in the section "Innovations" of Russian National Universities Ranking 2018 [8]. The main tangible elements of SPbU's innovation support system are: Head-office for the Use and Protection of Intellectual Property (with patent department), business incubator, students' start-up project contest. Nevertheless, academic entrepreneurship in SPbU is still in need for greater attention and greater amount of resources.

The research samples characteristics can be seen in Table 1 below.

Table 1 Characteristics of research samples.

Characteristics	Students	Faculty members
Total	250	63
Level of study / position	Undergraduate - 197 (79%) Specialty - 15 (6%) Master's degree - 27 (11%) Postgraduate study - 11 (4%)	Assistant lecturer – 4 (6%) Senior lecturer – 7 (11%) Assistant professor – 34 (54%) Professor – 9 (14%) Researcher – 2 (3%) Other – 7 (11%)
Gender	Men - 86 (34%), Women - 164 (66%)	Men - 26 (41%), Women - 37 (59%)
Age	18 or younger - 28 (11%) 19 years old - 70 (28%) 20 years old - 62 (25%) 21 years old - 43 (17%) 22 years old - 16 (6%) 23 years old or older - 31 (13%)	26-30 years old – 2 (3%) 31-35 years old – 2 (3%) 36-40 years old - 5 (8%) 41-45 years old - 4 (6%) 46-50 years old - 1 (2%) 51-55 years old - 3 (5%) 56-60 years old - 5 (8%) 61 years old or older - 4 (6%)

Fields	Economics - 151 (60%) Business Informatics - 2 (1%) Mathematics, programming - 40 (16%) Electronics - 40 (16%) Other social sciences - 10 (4%) Other exact and natural sciences - 7 (3%)	Economics and management - 43 (68%) Information technology and programming - 5 (8%) Other exact and natural sciences - 6 (10%) Other social sciences - 9 (14%)

At the beginning of the research, the following hypotheses were stated:

- H_1: personal characteristics of the respondents (gender, age, year of study, field of study, position) influence the distribution of their answers to the questions about entrepreneurship, including academic entrepreneurship;
- H_2: business experience matters for business ideas creativity;
- H_3: respondents prefer financial support from university;
- H_4: faculty members' age is significant for entrepreneurial aspirations;
- H_5: faculty members with intellectual property rights (IPRs) tend to be interested in participation in academic entrepreneurship.

Additionally, we analyze the data to identify the main obstacles for students and staff engaging in academic entrepreneurship.

3.2 Testing the research hypotheses

As it was mentioned before, the responses were gathered through online forms. They were processed with instruments of MS Excel 2013 and IBM SPSS Statistics software (version 23). Statistical analysis of the results obtained was hampered by the nominal nature of the data. The main analysis tools were descriptive statistics, cross-tables and pivot tables. The results were also tested with the Kendall's Tau Correlation Coefficient. The choice of the latter is determined by the nature of the data: most variables are expressed in nominal scales, they are independent, the sample size is limited.

The results of hypotheses testing are presented in Table 2.

Table 2 List of hypotheses.

No	Hypotheses	Result of testing
H_1	personal characteristics of the respondents (gender, age, year of study, field of study, position) influence the distribution of the answers	partly confirmed
H_2	business experience matters for business ideas creativity	confirmed
H_3	respondents prefer financial support from university	not confirmed
H_4	faculty members' age is significant for entrepreneurial aspirations	partly confirmed
H_5	faculty members with IPRs tend to be interested in participation in academic entrepreneurship	not confirmed

The H_1 hypothesis was verified to various extent: with respect to *gender* (women are less inclined to start business and they less often have business ideas), *year of study* (older students of bachelor programs think slightly more often about possible entrepreneurship), *position* of faculty members (assistant professors are more eager to be engaged in academic entrepreneurship projects, professors are more focused on education processes).

Testing of H_2 hypothesis resulted in its absolute confirmation: those who have some business experience always have new business ideas. That means that people with business experience do not lose the desire to be entrepreneurs and they can be used as first participants for academic start-ups projects.

Usually, the lack of finances is named among the main obstacles to starting business in Russia. Nevertheless, the H_3 was not confirmed. In fact, respondents would value educational support and consultancy services more than money.

No strong evidence was found that age of faculty members affect their entrepreneurial aspirations (H_4 hypothesis). It can only be concluded that the oldest generation is less inclined for business creation.

Analysis of the responses related to H_5 hypothesis revealed no connection between possession of IPRs and business intention. At the same time, there is some prove that faculty members consider IPRs only as acknowledgement of high-level research or as a source for possible royalties (i.e. passive income).

Among the main obstacles, the respondents mentioned:

- lack of financial resources (compare this to the results of testing H_3 – obviously, they do need money, but don't expect it from the university);
- lack of entrepreneurial experience;
- no adequate team available;
- lack of time.

Most of those obstacles can be overcome through widening networking and experience sharing – in other word, through developing organizational culture.

Apart from those results, poor awareness of existing support was discovered. A great part of respondents chose university's package support as a desirable assistance (which combined various ways of support). That choice can indicate their uncertainty about the specific instruments available in the university. In addition, some share of respondents named the forms of university's support that did not exist at the time. All that signify low level of respondents' awareness.

One other issue is worth mentioning: during preliminary interviews much doubt was expressed referring the ability of the university's management to organize academic entrepreneurship support without establishing unbearable bureaucracy. Such opinion is quite justified, since without experience university administration might try to control as much as it can through formal rules and full reporting system.

Additionally, it has become clear that there are indeed students and faculty members that potentially can take part in entrepreneurial projects, but they are not sure about being entrepreneurs themselves. It is well known that business ideas initiators cannot carry out their projects by their own. They need peer-support and allies. For developing entrepreneurial ecosystem in a university, the followers are as much important, as leaders are.

Summing up, the most important result of the research is that there are potential entrepreneurs in universities; but they do not have clear understanding of academic entrepreneurship and university's role in this process.

3.3 Future research

Analysis of the data has shown that there is a problem of trust: some respondents left comments that they would be interested in academic entrepreneurship, but they were not sure about their university being a trustworthy business partner. So far, we attribute that to the lack of academic entrepreneurship experience of both sides. Potential entrepreneurs are concerned with possible excessive control from university's administration. In return, universities managers are not certain on what kind of result they can expect (quite often, they choose financial compensation that can not be obtained from start-ups during the first years).

During the surveys, not enough data was obtained to identify the difference between business aspirations of students of various fields of study. That research question is still to be investigated.

4. Conclusions

Organizational culture adjustment should be regarded as one of the components of the process of university's transformation into entrepreneurial one. The results of our research can be used for designing the strategy of a university's organizational change. The surveys showed the need for the actions aimed at revealing the academic entrepreneurship opportunities for student and faculty members. Despite poor awareness, a substantial part of respondents would be interested to some extent in participating in academic entrepreneurship projects. They can form the group of early adopters for the implementing entrepreneurial principles.

Furthermore, the trust issue should be the object of the further research. For that barrier will not allow academic entrepreneurship to flourish.

University's administration, students and employees should cooperate closely with each other in cultivating entrepreneurial organizational culture.

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Abbreviations
Intellectual property rights (IPRs)
Research and development (R&D)
Small to medium-sized enterprises (SMEs)
St. Petersburg State University (SPbU)

BUILDING NEXT GENERATION OF GLOBALLY RESPONSIBLE DIGITAL ENTREPRENEURS

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Abstract
Digitalisation is becoming a significant area of entrepreneurship. We can observe business models that rely substantially on the internet to deliver services and products. On the other hand, one of the most critical challenges for enterprises is environmental protection. In this paper we try to combine the two mentioned areas; therefore, this paper aims to present research results on competencies required by responsible digital entrepreneurs, performed within an Erasmus+ funded project DIGI-GRENT: Building Next-Generation of Globally Responsible Digital Entrepreneurs (2018-1-ES01-KA203-050046). Although digital entrepreneurship is noticeable in business practice, the academic literature covering this topic, especially providing related research results, is scarce and this paper addresses the existing gap. The project consortium implemented the research among companies from four European countries: Greece, Italy, Poland and Spain. The presented results focus on the evaluation of the importance of skills in three areas: management, digital and sustainable.

Keywords
Digital entrepreneurship, Digital skills, Managerial skills, Research results, Sustainable skills

1. Introduction

Digitalisation is becoming a significant area of entrepreneurship. We can observe business models that rely substantially on the internet to deliver services and products [1]. Digitalization of business activities goes beyond that and can be represented by the use of digital supply channels [2]; digital manufacturing [3]; the use of digital technologies - 3D printing, cloud computing and electronic development platforms [4], [5], [6], etc. Although digital entrepreneurship is noticeable in business practice, the academic literature covering this topic, especially providing related research results, is scarce [7].

On the other hand, one of the most critical challenges for enterprises is environmental protection. The scarcity of natural resources, declining biodiversity or air, soil, and water pollution, push companies to focus on sustainable development and include responsible agenda in their business goals. The precautionary principle [8] and the pollution prevention approach [9] show the main directions of acting for business organisations, including those in the digital area [10], [11].

In this paper we try to combine the two mentioned areas; therefore this paper aims to present research results on competencies required by responsible digital entrepreneurs, performed within an Erasmus+ funded project DIGI-GRENT: Building Next-Generation of Globally Responsible Digital Entrepreneurs (2018-1-ES01-KA203-050046).

2. Digi-Grent Project

The DIGI-GRENT project aims to develop an innovative, transnational framework that will improve the knowledge and skills of academic institutions to produce more market/start-up oriented digital and responsible entrepreneurship (DREP) curricula.

The project consortium comprises academics, investors, industry and employment associations, start-up associations, and societal growth partners from different sectors who will co-create the envisaged DREP curriculum and will pilot it through an open innovation and co-creation virtual learning environment (VLE). Namely, the project consortium is led by the University of Almería, while other academic partners participating in the project are: The South Eastern European Research Centre, University of Lodz and Formazione Manageriale e Ricerca sul Management (ISTUD). Academic partners are supported by business environment organisations, such as Federacion Empresarial Metalurgica Valenciana (FEMEVAL), Foundation for Promotion of Entrepreneurship in Lodz, Greek Exporters' Association (SEVE) and associated partners comprising The Triple Helix Association, Hellenic Business Angels Network, Young Entrepreneurs of Thessaloniki and Andalucia Emprende.

This extensive coverage of different stakeholders within the consortium will allow working under the quintuple helix-academia cooperation for innovation and best practices concerning DREP, and further can also support policy reform in this area, leading to more prepared graduates ready for the start-up market. DIGI-GRENT also follows up the recent plans of the European Union to promote improved, efficient and clean operations by 2050 and is also relevant to the EU2020 targets for R&D, climate change, energy efficiency, entrepreneurship and social cohesion.

3. Research on responsible digital entrepreneurship

3.1 Research methodology

An essential part of the DIGI-GRENT project is research aimed at the identification of competencies required by responsible digital entrepreneurs, especially that academic literature providing empirical considerations within this area is limited [7].

The developed questionnaire has been based on the performed a systematic literature review of academic and non-academic literature review. Academic literature review (ALR) focused on:

- Databases: Scopus, Web of Science, EBSCO and Google Scholar.
- Search fields: title, abstract, keywords.
- Timeframe: 2008-2018.
- Type of publications: published journal articles in English with the availability of the full text (excluding proceedings, books, working papers and other types of publications).

As for the keywords, we referred to the following search phrases:

- (missing OR key OR critical) OR/AND (training needs OR training needs analysis) OR/AND (skills OR competencies OR abilities) AND (digital entrepreneurs OR digital entrepreneurship) OR/AND (sustainable entrepreneurs OR sustainable entrepreneurship OR responsible entrepreneurs OR responsible entrepreneurship).

During the search, we concentred on the 50 top cited papers identified in each database. However, this assumption was sometimes substituted by relevancy matching in order to obtain results better aligned to the investigated thematic area.

The ALR was followed by the non-academic literature review (NALR), that had the same focus in terms of the timeframe and searched keywords. Nevertheless, the scope concentrated on:

- Database: Google.
- Search fields: MBAs, professional courses/programs.
- Other requirements: identified courses should be offered by recognised universities/business schools/providers; programs with learning outcomes/training goals or skills should be accessible.

The ALR resulted in the identification of 31 papers that we included for further analysis, whereas as a result of NALR we identified 13 organisations providing education (both undergraduate/postgraduate and vocational) on digital and/or sustainable/responsible entrepreneurship and analysed the programmes in order to determine the key competencies and skills [7], [12-21]. As a result of both parts of the literature study, we have developed a questionnaire, including the selected, following parts:

- The extent to which digital activities are included in business models of surveyed companies as "developers/providers" and "users".

- General entrepreneurial and managerial skills and competencies, comprising: Opportunity recognition; Networking; Flexibility and adaptability; Communication with stakeholders: customer/supplier and others; Interpersonal relations/teamwork; Organising business: day-to-day operation management, business process management, etc.; Business architecture: strategy, long-range management, etc.; Financial management; Access to early-stage financing.
- Digital entrepreneurship skills and competencies, comprising: ICT management; Digital security; Social media marketing / digital marketing; E-commerce/m-commerce; Digital communication and social networks; Digital innovation; Online business: online business model generation, online opportunity recognition, etc.
- Sustainable /responsible/green entrepreneurship skills and competencies , comprising: Business ethics; Corporate social responsibility; Sustainable strategic management; Sustainable operations management; Sustainable marketing; Sustainable research and development; Sustainable business model development; Sustainable challenges anticipation: foresighted thinking; Social/environmental/economical (CSR) problems identification and management; Understanding sustainable-relevant systems and subsystems; Understanding sustainable-relevant standards.

The computer-assisted web interview (CAWI) was executed in 4 European countries, in which the DIGI-GRENT project is being implemented (Greece, Italy, Poland, and Spain). From March to May 2019, we gathered 205 responses included in the research sample (ca. 50 per country).

In order to evaluate the importance of skills, we used a 7-point Likert scale, where 1 indicated that the surveyed skill is important/relevant at all, and 7 indicated that the surveyed skill is very important/relevant.

3.2 Research results

The majority of the enterprises in the research sample could be characterised as small employing less than 50 people (64%) and operating on the market for more than 5 years (81%) (see figures 1 and 2).

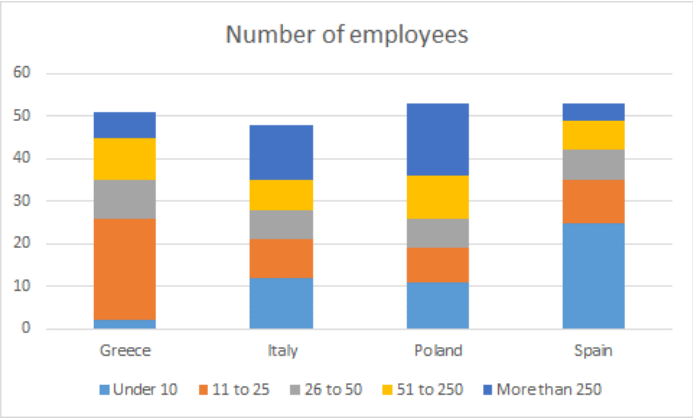

Figure 1 Number of employees per country.

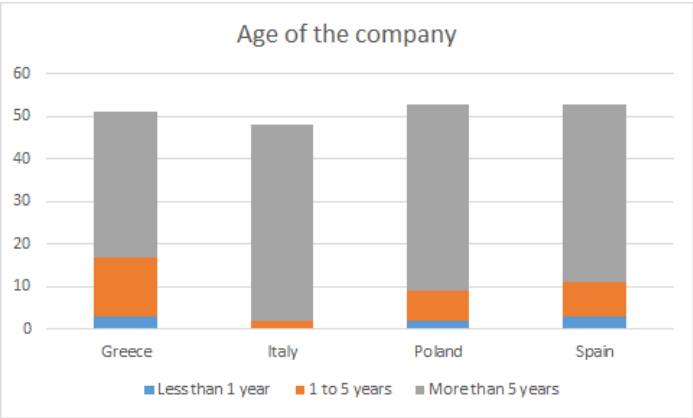

Figure 2 Age of surveyed companies per country.

In our research, we have both focused on digital products and/or services providers and users. The shares of providers varied between 30% in Spain and almost 60% in Greece, whereas the shares of users were higher, ranging from 73% in Italy to 98% in Spain (see figure 3).

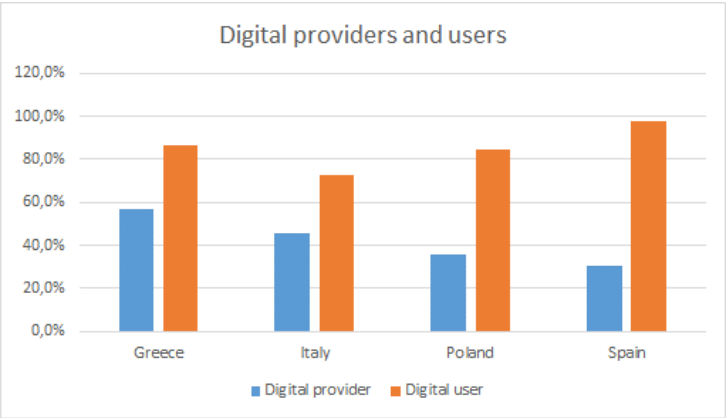

Figure 3 Shares of digital providers and users per country.

The importance of managerial skills on the used scale was evaluated from 4.94 (Access to early-stage financing) to 5.82 (Flexibility and adaptability; Interpersonal relations/teamwork). Other essential skills highlighted by the respondents were: Networking (5.74) and Communication with stakeholders: customer/supplier and others (5.71). As for the countries, the average importance varied from 5.56 in Spain (SD=0.20), 5.50 in Greece (SD=0.14), 5.69 in Poland (SD=0.54) to 5.72 in Italy (SD=0.60).

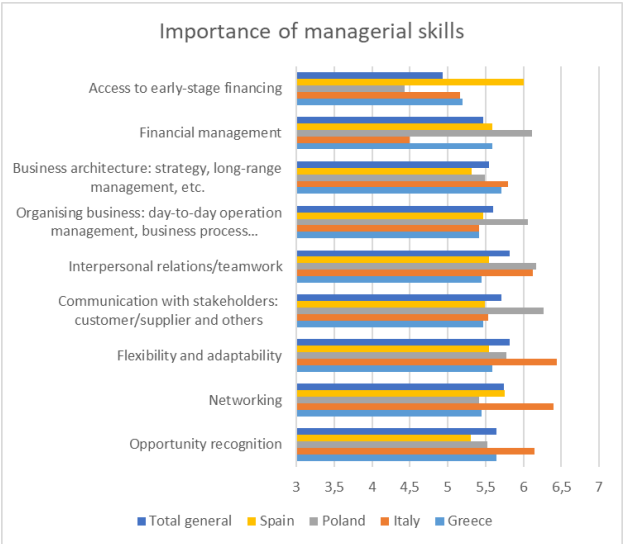

Figure 4 Importance of managerial skills per country and in general.

The next part of the survey focused on the importance of digital skills as the most important among them were considered Digital security (5.67), followed by ICT management (5.35), Social media marketing / digital marketing (5.19) and Digital innovation (5.17). The country perspective could be characterised as follows: 4.63 in Spain (SD=0.46), 5.13 in Greece (SD=0.21), 5.23 in Poland (SD=0.60) and 5.44 in Italy (SD=0.39).

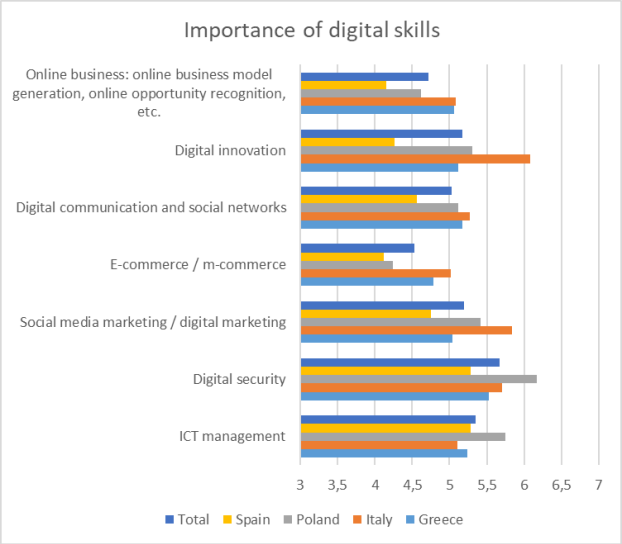

Figure 5 Importance of digital skills per country and in general.

Finally, among sustainable/green skills, the highlighted ones were: Business ethics (5.64) and Corporate social responsibility (5.03). The importance of all the other skills in this area was evaluated below 5. As for the countries, the average importance varied from 3.34 in Poland (SD=0.97), 4.12 in Spain (SD=0.51), 4.96 in Italy (SD=0.41) to 5.02 in Greece (SD=0.34).

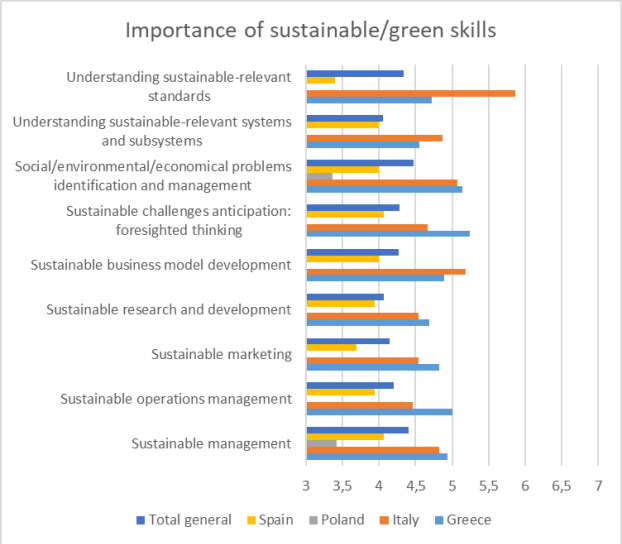

Figure 6 Importance of sustainable/green skills per country and in general.

4. Conclusions

This paper aimed to present research results on competencies required by responsible digital entrepreneurs, performed within an Erasmus+ funded project DIGI-GRENT: Building Next-Generation of Globally Responsible Digital Entrepreneurs (2018-1-ES01-KA203-050046).

Given the scarcity of the results of research on responsible digital entrepreneurship, this study is one of the few, that explores this subject. This paper focuses on the descriptive analysis of selected, initial data resulting from the conducted research. Nevertheless, we plan to publish full research data, as well as results of comparative and statistical analyses in the nearest future.

We will also use the findings of the research in the course of the presented project. The university-industry links, developed through co-creation in the DIGI-GRENT project will allow us to use the academic knowledge provided by higher education institutions and offer solutions to the entrepreneurs (current and future ones) to improve the required competencies (both in the digital and sustainable area).

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THE COLLABORATIVE ECONOMY THROUGH THE LENS OF SUSTAINABLE TOURISM. A REGIONAL-CENTRIC VIEW

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Abstract
This paper is a mix of a quantitative-qualitative research that analyses - based on semi-structured surveys of/with the users of collaborative platforms - the perception of the travellers about the new type of accommodation and the new on-line service, that offers the greatest possibilities for the development of the collaborative tourism in the Brasov County. The expression "collaborative economy" has, in the context of the present paper, the same meaning as "sharing economy". In the particular case of tourism, one can say, paraphrasing a work by Botsman, R., & Rogers, R. [1] that „what's mine is yours", because the collaborative economy in tourism means a marketplace where consumers rely on each other, they act by changing, renting, swapping and sharing their accommodation locations. The purpose of the present paper is to give answers to one of the most important challenges of the City of Brașov, such as the management of the touristic offer, considering the growth prospects for the next years, adopting a proactive attitude and putting in the foreground the rights and interests of both owners and tourists. This could be done by taking into account the pressure that this type of renting may be exerting on the increase of rental prices of long-stay housing, along with its possible substitution effect with the consequent depopulation, as well as the neighbourhood coexistence, but also taking into account the impact of a possible unfair competition on other segments of the touristic market and the change in the physiognomy of the cities of Brașov County.

Keywords
Airbnb online platform, Dynamic city, Sustainable collaborative tourism, Urban tourism with sustainable opportunities.

1. Introduction

From a sociological point of view, and within a scenario of globalization and multiculturalism, it is argued that members of different countries around the world (and particularly Western Europe) move easily and communicate fast. They are increasingly using new technologies and ICTs. [2] points out that young people have unified tastes in music, sports and cultural activities and obviously, in tourism. For this reason, the European market is becoming homogeneous in its purchasing needs and behaviours. In this respect, some sociologists Appadurai [3] have proposed that global currents are "mutating the effect of divisions" by dropping traditional national boundaries because of the reach of the media (Internet, cable and satellite television, TV channels as Travel Channel and National Geographic). Other reasons for a better link between people are ethnic outreach (tourism, international exchanges in higher education, such as the Erasmus+ academic program), the scope of ideas (political ideas such as ecology), technological and financial scope. From this perspective, culture would no longer be defined in isolation for a country [4]. Therefore, research addressing the socio-cultural, experiential, symbolic and ideological aspects of consumption appear [5].

From an economic perspective, some studies in Europe have noted that, although substantial differences still exist in the context of marketing, there are tendencies that homogenize consumers. For example, the share of expenditures is increasing in the same time with the collaborative economy, along with the development of environmental and health concerns, while durable consumption decreases over time [6].

In the field of marketing there are several investigations that try to contrast the existence of convergences between young European consumers. Some writers insist on the trend towards globalization, especially in certain product categories, such as fashion, automobiles, beverages and food products. In fact, there is talk of the birth of international products, designed to meet the needs of cross-cultural consumer segments [7]. In Asia, for example, researchers have concluded that there are some common structures in the consumption values [8]. Using the Consumer Styles Inventory developed by Sproles and Kendall [9], other authors established that young consumers' decision-making in Korea is almost like that described in the United States [10]. It has also been

found that all Western European countries (except Germany) have very low levels of materialism, compared to other nations, such as the United States or the countries of Eastern Europe [11].

On the opposite side, another stream of literature is presented, which does not share the existence of a Pan-European consumer. This trend argues that segments can be identified according to nationality. One of the main contributions to this topic is the research conducted by Hofstede [12] in 66 countries on work-related values. Also, [13] develops clusters of consumers in 17 countries of Western Europe, looking for groups of homogeneous "Euroconsumers" in terms of power distance, avoidance of uncertainty, individualism and masculinity. The author identified three groups of countries with interesting implications for adapting the positioning of the product and advertising to the cultural characteristics of each block. In the same line Hofstede, et al. [14] have carried out a segmentation in several European countries based on the most consumed products. They found that, even though one of the four segments identified was Pan-European, cultural differences between European nations prevailed. Specifically, this identified Pan-European segment comprises precisely the younger, more educated, higher-income consumers living in urban areas. Likewise, in an exploratory study, [15] examines the applicability of the Theory of Planned Behaviour to Green Purchasing Behaviour in the Chinese and American cultural settings. Although the existence of cultural differences in Europe remains the dominant theory in marketing literature, one tried to prove that these are attenuated when talking about young people. This is thanks to a long period of European integration and to the construction of a "common spirit", which leads to reducing the differences between the nations of the Old Continent. Indeed, recent studies have argued that the nationality does not influence the purchasing process, recommending the adoption of standardized marketing strategies, with all the advantages that this entails [16, 17].

2. General Objective, Research Assumptions and Methodological Tools

In the context of the trend known as "collaborative economy" or "sharing economy", a wide variety of business models have been developed in different sectors and activities[18] demonstrating that, when it comes to business models, Airbnb may be more than an exception, since the platform's viability depends on the value of listed items, the profit an owner can make, and the cut of the intermediates. In the collaborative economy sector, Airbnb (www.airbnb.com) is a reference case [19] that followed the scheme of disruptive innovation [20]. Airbnb would initially have significant disadvantages when it comes to competing with other more traditional alternatives available to tourists when selecting accommodation, such as quality of service, friendliness and availability of staff, brand reputation and security [21, 22].

The *general objective* of the study is to inquire about the incidence and possible development of the collaborative tourism in Brașov County while *its specific objectives* are as follows:

- Understanding the purpose of the collaborative tourism and its main characteristics.
- Understanding the importance of ICT in relation to the collaborative tourism.
- Knowing the state of development of the collaborative tourism in Brașov County.
- Depicting the offer and the demand profile of the users of this modality, at the local level.

The assumptions established by the work hypothesis are as follows:

- H1: Accommodation is the service that offers the greatest possibilities for the development of collaborative tourism.
- H2: ICTs are the basis for the practice of this new trend.
- H3: The demand segment targeted by this trend consists of young people seeking to generate a closer bond between resident and visitor.

As it is a relatively new phenomenon, of which there is neither an extensive knowledge nor specific studies in Brașov County, this is an exploratory investigation. Also, it is intended to determine the existing trends in a little explored environment. Exploratory studies are usually done when the objective is to examine a research topic or problem that has not been studied or has not been addressed before.

The *methodological tools* used for obtaining the data and information that guided the scientific approach, refer to:

- Collection of conventional (bibliography) and non-conventional (Internet) documentation.
- Semi-structured surveys with the users of collaborative platforms.
- Semi-structured surveys with a sector of the population of Brașov County.
- Survey and evaluation of the tourism-recreational offer, performed online.

For the development of this research paper, the authors set out to meet *the objectives* related to collaborative tourism within the city. For this, an extensive bibliographic survey was carried out, in order to understand the scope of the collaborative tourism and its main characteristics.

Different collaborative platforms were also consulted in order to know the development status of this modality in Brașov County. At the same time, surveys were carried out to discover the residents' knowledge of the subject. Other surveys were targeted people who use these services, as a way to travel within the city, thus allowing a

proper characterization of demand. In this way, the general objective of the paper was achieved, i.e., to investigate the incidence and the possible development of the collaborative tourism in Brașov County.

In order to see what the situation was in Brașov County, regarding activities linked to the collaborative tourism, a survey of/about the main collaborative platforms was carried out by the authors of this paper. It began by analysing the ones that are contacted by the people who want to rent or lend a space, in this respect the most known and representative being Airbnb. Then, another platform such as Uber and Couchsurfing were taken into account, groups on Facebook, and pages that group real estate advertising. In each case, it was detailed in what moment the data were obtained, because the intention was to compare the development of the collaborative tourism in a determined period of time.

In the case of Airbnb, at the time of the first analysis (between 01/04/2018 to 30/04/2018), there were found 45 space rental advertisements. By applying filters on the web page, information was retrieved about the services offered by each host. The second part of the analysis was performed on May, the same year, yielding a total of 52 advertisements.

Table 1 Services offered via Airbnb advertisements, in Brașov County.

Services offered	Number of ads that serve the service	Number of ads that serve the service
	April 2018	May 2018
Wi-Fi	42	47
Swimming pool	8	4
Kitchen	42	46
Accessibility for disabled	7	8
Breakfast	13	10
TV	40	47
Satellite TV	12	9

In this table, one can see that the services that the most accommodation locations provide, are: Wi-Fi, kitchen and TV.

From these data, it could be observed that the number of accommodation locations offered was higher in May than in April, however, in some cases the services decreased, which indicated that, in some accommodation locations they were no longer offered, or that the accommodation locations are not the same. Also, through the page, the researcher could apply a filter to see what type of property is the one that was rented. The surveys were carried out to obtain knowledge about the issues that matter for the citizens of Brașov. These were designed through the Google Forms and were made via the Internet, from the social network Facebook. Of the 225 surveys answered, only those of the residents in Brașov County, that is 208 surveys, were taken into account. They were answered by a /diverse/ heterogeneous group of people, having various occupations such as students, independent professionals, public and state employees, among others. As for the age of the respondents, it varied between 17 and 77, with a majority of people with ages between 20 and 30 (more than 50%). Most of the time, the respondents recognized some of the platforms mentioned in the survey, but said they did not know about Collaborative Economy, Collaborative Consumption or Collaborative Tourism terms. That is, only 29% know any of these terms, but more than 50% recognize some collaborative platform. The one that was the most identified by the respondents was Airbnb, followed by Uber and other platforms, as can be seen in Figure 1.

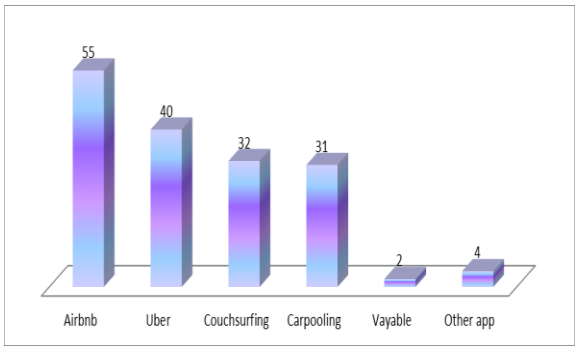

Figure 1 The degree of use of different ICT platforms.

It was further assessed if those people who knew about the collaborative ICT platforms also used them, how often and what role they played in their lives, that is if they were users, providers or both. According to the results of the analysis, it resulted that Uber and Airbnb were the platforms people used the most.

According to the role of users, of the 109 respondents who have ever used a collaborative platform, 90 said they had demanded the service, while only 4 users had offered a service. The rest of the 15 respondents who used collaborative platforms, stated they played both roles, meaning they offered and demanded a service by this tool, as shown in Figure 2.

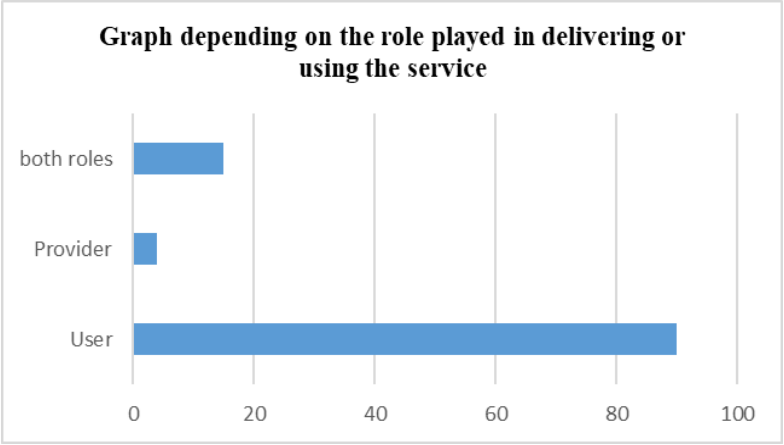

Figure 2 The respondents' answers regarding the role played in delivering or using the service

This analysis encourages us to go further, because it is obvious that the number of applications for living space is much higher than the number of spaces offered, and the number of those who act as both users and providers is 14%. It is clear that, there is a market for this business model, but we need to identify the reasons that are still unbalancing a higher demand against lower offer. And for this reason, we will continue to explore other attributes of the researched area.

2.1 Expanding the Research in the Near Future

Given the very rich offer of collaborative tourism, the authors of the present paper consider that, what has been done so far, namely the collection and analysis of the specialized literature and specific documentation, is an excellent, but not sufficient starting point. The results of semi-structured surveys on topics such as the main collaborative platforms, main services offered or the role played in delivering or using the service, have also been analysed.

The intention of the authors is to continue and deepen this research through the continuation of semi-structured surveys that clarify the following areas of interest: customer strength position, the power of customer negotiation, types and numbers of accommodation locations offered by Airbnb in Brașov County, the language of the hosts, the types of rooms, the number of guests, the place of origin of the tourists, the hosts preferences, other relevant aspects.

The purpose of continuing this exploratory research is to verify the assumed hypothesis and to clarify to what extent the specific research objectives can be achieved. Only in this way, we will be able to determine if and to what extent, the general objective of the current paper, namely the incidence and the possible development of the collaborative tourism in Brasov, is to be achieved.

We, therefore, propose to deepen the research and to go beyond the current limitations of the editorial space and to publish a much more comprehensive research in the field of the cooperative economy in tourism. We also want to introduce a new direction of research, namely how this collaborative economy can turn into a future direction of interest for small and medium-sized enterprises.

3. Conclusions

Finally, a conclusion linked to the tourist activity of Brașov County is to consider the collaborative tourist who visits the city, approaches it as a mid-point within his or her journey. It also highlights the features of the city that, make the development of the collaborative tourism possible, considering its strategic location, the diversity of activities one can attend, the culture and history and also, its municipality work teams that are responsible for

cultural activities and generate technological applications that contribute to the development of the city. Not least, we have to consider its young population with a good management of the ICTs.

It is concluded that, for a sustainable development and management of this new trend, it is necessary an informative campaign to be conducted, aiming to present the population the benefits and disadvantages that can be generated by approaching the collaborative tourism. It is also essential, as new needs arise within the society, agreements to be signed between the private and the public sector, for a joint, effective cooperation, taking into account that the collaborative economy can be a key tool for development and advertising our country worldwide.

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SUPPORTING SME INNOVATION, GROWTH AND NEW BUSINESS DEVELOPMENT BY REGIONAL ENTREPRENEURSHIP MODEL

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Abstract
To enhance small and medium sized enterprises' (SMEs) business development Laurea University of Applied Sciences will build a training programme and engage the student and staff in the development work. The students, who choose a company to follow, may also attend the training programme together with their tutor. Both the company participants and the students' experiences will affect the final model. SMEs are often unable to give enough thought for the future business innovation. On the other side, the students and teachers from the universities of applied sciences are so engaged in their disciplinary content that more advanced skills for entrepreneurship may suffer. Our aim is to bring these together in a holistic pedagogical framework. We will create a permanent platform for matching the development of SMEs and university students' studies. The regional model is built together with Regional Business Development Organizations who work with companies on daily basis. Methodological framework consists of Learning by Developing (LbD) action model. It is a pedagogical approach in which learning is linked to applied research, development projects and regional developing. For SMEs, it gives new perspective for customer and business surface evaluation.

Keywords
Business development, Coaching, Entrepreneurial capabilities, Regional innovation ecosystem, SMEs

1. Introduction

Enabler for innovative knowledge and competence creation

The main framework for creating entrepreneurial education is Learning by Developing (LbD) model. LbD is a pedagogical approach [1] in which learning is linked to applied research as well as research, development and innovation projects (RDI) and regional developing. In this framework, much emphasis is given to the social interaction, knowledge and competence sharing, researching and problem solving. LbD improves mobilization of talent resources of the region, which allows new ways for innovative knowledge creation. Learning and RDI practice meet to add value to the students as well as enterprises in the region. For the companies LbD offers the knowledge, creativity and the contact network of the universities including their students and staff.

Regional role and growth potential of SMEs

SMEs are important for various reasons. In 2011 63 percentage of all employees worked in small and mediums sized enterprises [2]. Of the new working places, 90 % was created in companies, which had less than 50 employees. Only 4 % was created in companies, which had more than hundred employees. This shows how important SMEs are in generating new work.

Small and medium-sized enterprises are in the focus of industrial policies as well because of their role in creating jobs, stimulating innovation and promoting entrepreneurial skills [3]. Both the firm's inherent characteristics and firm strategy as well as its operational macroeconomic environment determine SMEs performance [4]. Growth is [5] mainly measured by change in employment or sales. Regression analysis has been applied [6] on a sample of 298 Finnish SMEs across five industry sectors. Cross-relational network competence was found to be a significant predictor of growth in internationally operating SMEs. The network competence of domestically operating SMEs was not related to their growth.

Enhancing SMEs' development

We have earlier studied the needs of the SMEs by carrying out a company survey, interviews as well as two innovation workshops [7]. We found out, that the innovation process of machinery and metal sector SMEs is unclear and their contact networks are diffuse as well. There is very little, if at all cooperation with the universities. As SMEs need new capabilities in order to grow, cooperation and networks are crucial for them. Companies with a high innovation performance also seem to have a higher innovation capacity [8]. Therefore, the regional informal networks benefit especially SMEs as they gain access to the local information communities. Open innovation is also more widely used in regional and local networks. Small companies with their limited resources are therefore more bound to deep and long-lasting relationships.

Recent studies reveal that internationally grown SMEs share three dynamic capabilities: knowledge absorbing capabilities, acquisition and integration capabilities as well as dynamic internationalization capabilities. In addition, SME's foreign growth is positively linked to both its entrepreneurial as well as learning orientation [9]. In order to develop new capabilities SMEs, need both new tools and access to latest information and knowledge networks. Future orientation is important for gaining competitive advantage as well. The foresight process includes the provision of future information and its analysis and use for strategic decision-making. SMEs lack the ability for all of these stages. They need new dynamic tools and other support for their business development and innovation processes.

2. Framework

We have initiated a project for supporting SMEs growth and development of entrepreneurial capabilities of the university students at the same time. European Regional Development Fund and Helsinki-Uusimaa Regional Council are funding this effort. Radar-project and its activities form the general framework for entrepreneurial education development (Figure 1).

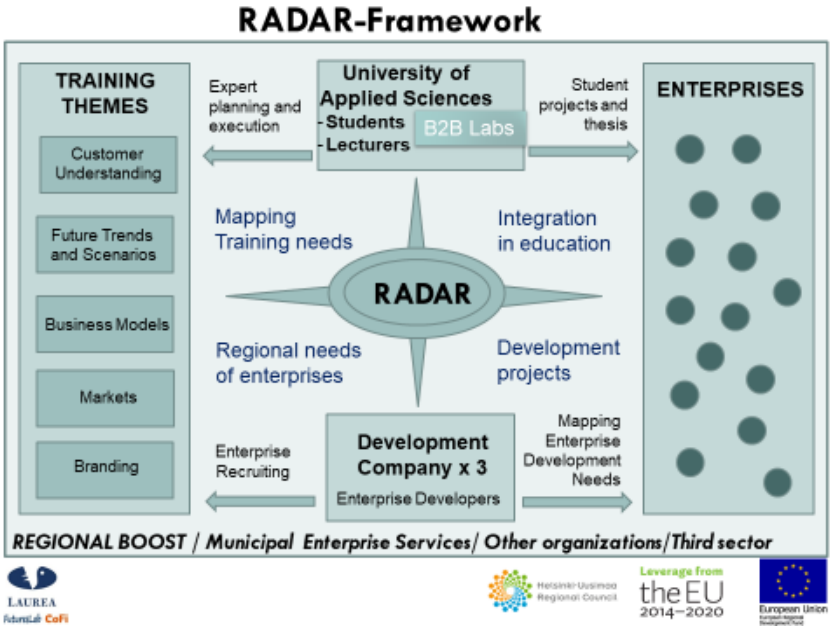

Figure 1 Joint regional innovation ecosystem and entrepreneurial education framework.

2.1 Regional cooperation model

Open innovation exploits the inwards and outward flow of information to speed up internal innovation process and explore new markets [10]. It also changes the core competence of the company. SMEs gain new possibilities through specialization and widening up their technological information base. SMEs seldom have time for this. Cooperation with universities is a way to faster learning and gaining new competence required by open innovation.

The future performance of the innovation system will mostly depend on the social processes between regional economic actors. Regional information networks may also explain differences in the efficiency of open innovation. Innovation requires institutional learning concepts and probably regional concepts as well. Interactive learning functions become crucially important for the whole process. From this framework, innovation is constructed of three overlapping processes: the production of scientific and technological

knowledge, the translation of knowledge into working artefacts and responding to and influencing market demand [11]. Training themes have been selected in order to answer the dynamic competence needs of SMEs. Natural innovators possess five key skills: questioning, observing, networking, experimenting and associating [12]. In entrepreneurial education, the basic idea is that activities open one's mind to new ideas [13]. We experiment developing entrepreneurial mindset with entrepreneur and student co-development (Picture 2).

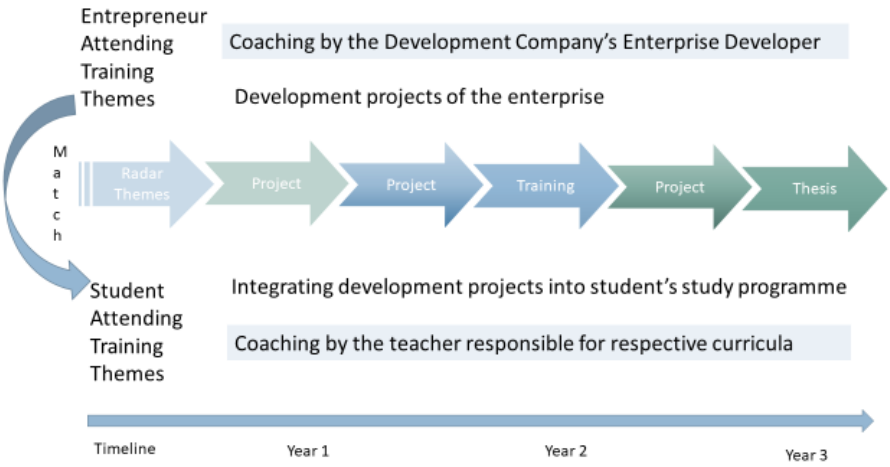

Figure 2 Entrepreneurial Path of a Student in co-development process.

The regional innovation system consists of a set of institutions whose interaction determines the production, diffusion and use of economically useful knowledge. This is a graduated and cumulative process where innovations are resulting ultimately from processes of learning, searching and exploring. Key actors in production and innovation systems apart from business companies are universities, private and public research institutes, organizations of technology transfer and the government [14]. Our regional model for SMEs is entrepreneurial in nature. The regional development companies interact with the participating companies in daily basis and consult them in growth planning. University of Applies Sciences serves as a resource base for both training of the company representatives as well as their development projects by its students. RADAR is the final cooperation and integration model to be established (see Picture 1). As there are three different regional realisation, we will face different regional needs as well.

2.2 Entrepreneurial capabilities

Learning outcomes of undergraduate entrepreneurship education can be divided in three parts: cognitive, skill-based and affective; and further into business-specific as well as interpersonal and personal content [15]. Many of these capabilities are skill-based and correspond to development project contents as well as personal skills in needed in conducting them. Further, we consider SMEs perfect places for learning broad entrepreneurial landscape. Therefore, we define three broad areas of dynamic entrepreneurial capabilities (Table 1), which can also be translated into fragments of evolutionary fitness [16] in dynamic capabilities framework.

Table 1 Dynamic Entrepreneurial Capabilities.

Capability	Evolutionary Fitness
Holistic view of enterprise and its functions	Technical fitness
Customer insight and value creation	Market demand
Going concern	Competition
Informal	Formal

The training program for SMEs consists of five parts: customer needs, future mapping, business model, markets and branding. Students that choose a company to follow through out their studies, participate in the training together with the company representative and their tutor. Cooperation between the company tutor, enterprise developer of the regional development company as well as university tutor is essential for the success of entrepreneurial education of the student.

2.3 Research methods

Methodological framework consists of Learning by Developing (LbD) action model as well Radar framework. They link together pedagogical approach, applied research, development projects, regional developing and in this case strategic management as well. In this action research process, 70 SMEs will go through the development route with their selected development projects and student engagement. Case study method will be used to highlight the approach, where students have chosen the entrepreneurial path.

We also study by surveys and in-depth thematic interviews, what effect the development activities have on the company business or even business model development. Is the multidisciplinary model beneficial for the companies and students? We will incrementally study both company participants' and students' experiences of the co-creation by separate surveys and final thesis of students. For entrepreneurial education, we use three level evaluation: self-evaluation by the student, evaluation by the entrepreneur and tutor as well as verifying structured interviews. Building a permanent model includes anticipating and matching diverse needs as well as defining the critical contact points for cooperation in the organizations.

3. Conclusions

Even though the interest from the SME side has turned out to be strong, only few students are expected to choose this co-development path together with an entrepreneur.

There exists permanent need for flexible cooperation between UASs and working life. Regional cooperation model offering both enterprises and students varied possibilities for development work will best serve this target. Moreover, the students choosing longer cooperation with an enterprise will gain deeper entrepreneurial skills and understanding of businesses. Entrepreneurship is first and foremost a mind-set [17] and it needs to be nourished by a variety of cooperation.

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QUADRUPLE HELIX CONFIGURATIONS IN CENTRAL AND EASTERN EUROPE. AN EMPIRICAL INVESTIGATION

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Abstract
With their emphasis on broad cooperation for innovation, the Quadruple Helix models are nowadays at the center of national and regional innovation policies all across Europe. In such a context, higher education institutions and research organisations, the business sector, the government and the civil society are expected to interact on a systemic basis, to strengthen their connections both within and outside the geographical boundaries and to create synergies for smart specialization. Despite recent developments, measuring and operationalizing the Quadruple Helix models is still a difficult task, which is hindered especially by the lack of relevant data. To fill this gap, our paper aims to investigate the Quadruple Helix configurations in Central and Eastern Europe, while relying on the database of FP7 projects implemented in these countries and their regions (NUT2) between 2007 and 2013. We are particularly interested in investigating the participation in FP7 projects by universities and research organisations (HES & RES), private actors (PRC), public bodies (PUB) and other actors, i.e. NGOs, associations etc. (OTH). Our findings reveal a very mixed pattern of engagement in FP7 projects and suggest different policy interventions to support the smart specialisation approaches and strategies.

Keywords
Quadruple Helix, Regional innovation systems, Smart specialization, Central and Eastern Europe

1. Introduction

In recent years, different conceptual frameworks have been proposed for analysing innovation dynamics in the knowledge-based society; among them, the Triple Helix of University – Industry – Government is one of the most influential models that consider both the relationships between the three institutional spheres and the transformation mechanisms that drive each of the spheres [1]. According to [2], a Triple Helix can be defined - according to systems theory - as a set of components, relationships and functions related to knowledge generation, diffusion and use. The importance of the relationships between actors in the helix system has now grown and is expected to result in new ideas of high level of innovative products and services, as creativity is born through the involvement of intellectuals (university), business, society, and government that provide regulations to support the creation of creative and innovative behavior of the business actors [2]. As pointed out by [3], using the Triple Helix model of university–industry–government relations, ”one can measure the extent to which innovation has become systemic instead of assuming the existence of national (or regional) systems of innovations on a priori grounds”.
More recently, the Triple Helix model has been further developed and extended. As pointed out by [4] the tripartite model is no longer enough in the context of smart specialisation; in addition, the innovation users or the groups that represent the ”demand-side” perspective and the consumers, together with the relevant non-profit organisations representing citizens and the workers should be strongly involved in the so-called ”entrepreneurial discovery processes”. In other words, the multi-level governance models that characterize the smart policy approaches should be user-oriented and include both the market and the civic society [4].

In the academic literature of the Quadruple Helix [QH] model, the fourth helix has been defined both as “a general backdrop” and as specific actors, such as users of technology and NGOs. One of these need not necessarily exclude the other, although the first interpretation could be perceived as a passive entity, while the other refers to active participators. On the contrary, the fourth helix, understood as a “creative knowledge environment”, implies that society in general is activated, and here, the first interpretation coalesces with the other [5]. According to [6],” Quadruple Helix, with its emphasis on broad cooperation in innovation, represents a shift towards systemic, open and user-centric innovation policy. An era of linear, top-down, expert driven development, production and services is giving way to different forms and levels of coproduction with

consumers, customers and citizens". In their turn, [7] propose a working definition of Quadruple Helix: "a collective entity formed by individual users living on a territory and interacting with university, industry and government as customers, citizens or members of a community in order to contribute to build new innovation paths which are able to promote the socio-economic growth of the territory".

According to [8], the Quadruple Helix visualizes the collective interaction and exchange of knowledge by means of the following four sub-systems: the *education system* refers to academia, universities, higher education systems, and schools (human capital); the *economic system* — consists of industry/industries, firms, services, and banks (economic capital); the *political system* formulates the direction in which the state/country is heading in the present and future, as well as the laws (political and legal capital); *the civil society* and *media based-culture* integrates and combines two forms of capital: social capital and information capiital [8].

The emerging relationships connecting organizations are the condition on which innovation is founded nowadays, so it is pivotal to achieve a deeper comprehension of the phenomenon through the exploitation of new dynamics and the exploration of new trajectories [9]. Due to a variety of individual, organizational and institutional factors and to local specificities, few ideal Quadruple Helix models can be found in practice and efforts are deployed to unlock the potential of each of the four "helices".

In such a context, our paper is meant to empirically investigate the Quadruple Helix configurations that exist in Central and Eastern Europe, while relying on the database of FP7 projects implemented in these countries and their regions (NUT2) between 2007 and 2013 [10].

2. Research method

To the purpose of our study, we include in the analysis the countries that were previously part of the communist block and joined the European Union after 2004 (n.b.: even if Croatia joined the EU in 2013, it has been an active participant in the E*U's FP7 programme since 2007).* We are particularly interested in investigating the participation in FP7 projects by universities and research organisations (HES & RES), private actors (PRC), public bodies (PUB) and other actors, i.e. NGOs, associations etc. (OTH). Table no 1 presents the number of FP7 projects per million population for each of the 11 countries considered in our analysis, while Figure 1 reveals the percentage distribution by type of beneficiaries.

Table 1 Number of FP7 projects per million population by type of beneficiaries

Country	HES	REC	PRC	PUB	OTH	Total
Bulgaria	32,02	29,08	26,28	6,57	7,41	101,36
Czech Republic	46,60	36,18	46,89	4,55	4,26	138,49
Estonia	141,39	44,09	143,67	28,89	70,70	428,74
Croatia	32,70	21,48	34,13	9,31	1,67	99,28
Hungary	61,66	47,42	46,91	13,94	5,39	175,32
Lithuania	61,68	24,60	35,69	21,83	3,81	147,61
Latvia	68,58	56,39	20,83	19,81	6,10	171,71
Poland	23,70	18,22	14,27	2,69	0,95	59,82
Romania	14,98	14,83	17,51	7,39	2,08	56,79
Slovenia	108,99	148,72	131,28	60,07	11,14	460,20
Slovakia	31,69	20,64	28,19	7,19	4,42	92,12

Source: Own computation based on CORDIS - EU research projects under FP7 [10] (2007-2013) and Eurostat (Population on 1 January by age, sex and NUTS 2 region) [demo_r_d2jan]

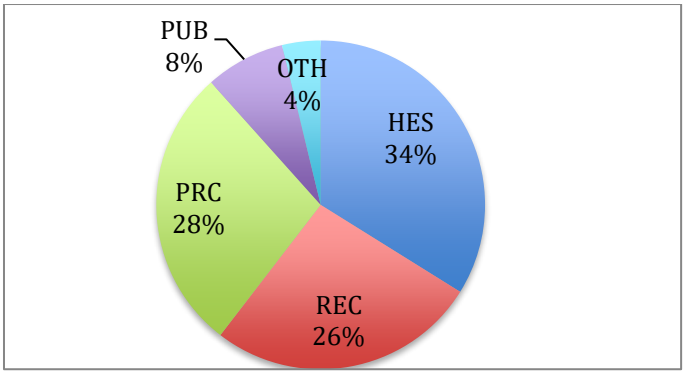

Figure 1 The distribution of FP7 projects in Central and Eastern Europe by type of beneficiaries

Source: Own computation based on CORDIS - EU research projects under FP7 (2007-2013)

As it results from the Table 1 and Figure 1, about a third of the FP7 projects in Central and Eastern Europe were applied by the higher education institutions (HES = 34%), with Slovenia and Estonia being by far the performers in this category, with more than 100 FP7 projects per million population (the performances are explained – to some extent - by the small size of population in these countries). The two countries are also leading the top of the private for-profit entities (PRC), whose share in the total number of FP7 projects at the level of Central and Eastern Europe is of about 28%. Research organisations (REC) come third, with about a quarter of the total number of FP7 projects, with Slovenia being again in the top of performers. Public bodies (PUB) – excluding research organisations and secondary or higher education establishments – account for 8% of the total participations, while other organisations (OTH = NGOs, associations etc.) were involved in only 4% the FP7 projects, with very large variations between the countries, i.e. in Poland there was less than 1 project per million population, while in Estonia there were more than 70 FP7 projects per million population involving such organisations.

To make the data comparable and shed light on different Quadruple Helix configurations in Central and Eastern Europe, we create a composite indicator to capture the intensity of engagement for each of the four ”helices” and for each region (NUT2) in the database; we considered HES and REC together, as a single helix, in order to get closer to the ideal Quadruple Helix model involving ”university” (HES & REC), ”industry” (PRC), ”government” (PUB) and ”civil society” (OTH). To calculate the scores for each type of beneficiaries, we have followed the next steps:

a) calculate the regional FP7 financial contributions per million GDP for each type of beneficiaries, so as to avoid the size biases;
b) normalize the data using a square root transformation, so as to avoid the biases due to large skewnesses;
c) compute the average scores for each of the four ”helices”, namely ”university” (HES & REC), ”industry” (PRC), ”government” (PUB) and ”civil society” (OTH);
d) assign a ”1” to all those values that were above the average scores in each of the helices and a ”0” for the scores below the average;
e) compute the final score for each region by summing up the individual scores across the four ”helices” and categorize the final scores as follow: ”0” and ”1” were assigned to the *”low performers/ single helix” regions, ”2” to ”double helix” regions, ”3” to ”triple helix” regions and ”4” to ”quadruple helix”* regions.

The map in Figure no. 2 gives a one-snapshot overview of our final results, shedding light on the different Quadruple Helix configurations in Central and Eastern Europe.

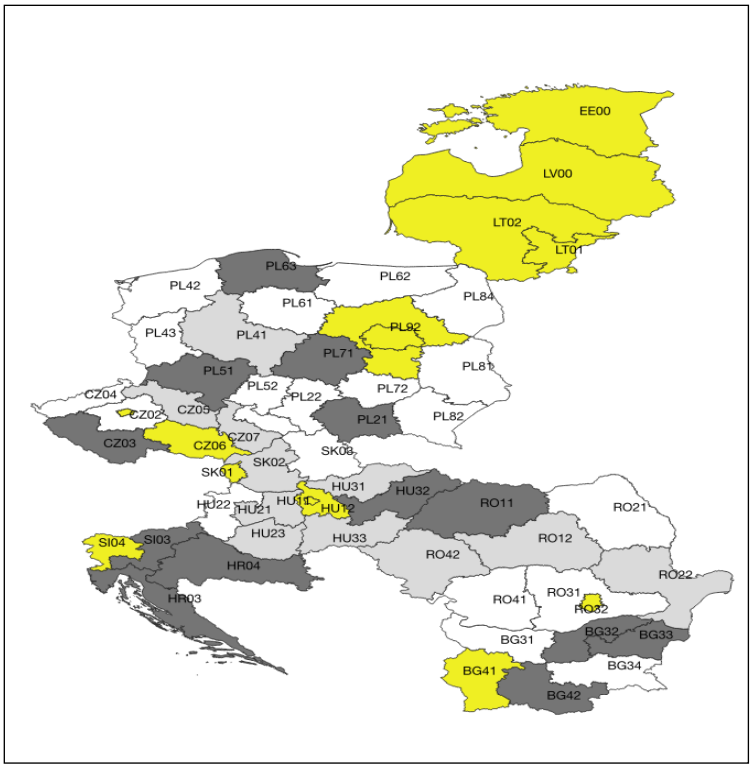

Figure 2 Quadruple Helix configuration in Central and Eastern Europe

Low performers/ Single Helix Double Helix Triple Helix Quadruple Helix

3. Conclusions and discussions

Our results reflected in Figure no 2 reveal a very mixed pattern of engagement in FP7 projects at the level of Central and Eastern European regions. By far, the most successful regions in engaging all types of innovation actors are the regions hosting the capital cities (Sofia, Bucharest, Warsaw, Budapest, Prague, Bratislava, Ljubljana), where large agglomerations exist and innovation intensity is much higher. Baltic countries, in their turn, fall into the category of Quadruple Helix regions, as they proved to be successful in engaging different types of beneficiaries.

Except for Croatia, Slovenia and the Baltic region, all the other countries have very mixed Quadruple Helix configurations. In almost all Triple Helix configurations, the ”missing actors” are be the public authorities or the civil society, while in the Double Helix configurations one of the other two very important actors – ”university” or ”industry” – is also missing. At the lower end of the spectrum, 20 out of the 56 NUTS2 regions in Central and Eastern Europe have low performances for all the four helices (a general score of ”1” or ”0”); only two regions in this group have a score of ”1” in the ”university” pillar and only one of them have ”industry” actively involved in FP7 projects.

We think our results have important policy implications, especially with respect to the smart specialization strategies that call for strong engagement of all Quadruple Helix actors. In those regions where there is strong capacity in all the four helices (*Quadruple Helix regions*), efforts could be directed towards strengthening cooperation and being more active in international networks as coordinators (not only as participants). In those regions with *Triple Helix configurations*, there is much space for the creation of regional clusters and ”coalitions”, as the ”missing links” here are the public authorities and the NGO sector; finding the best connections between the already established innovation actors, the policy-makers and the society could thus be a solution towards more efficiency and efficacy. Third, the *Double Helix regions* should first investigate where their weaknesses come from - be it from the ”university” or the ”industry” sector. Establishing branches of relevant universities and research organisations in such regions, so us to get connections to the national and European networks of knowledge and value chains or using multinational corporations as ”bridging mechanism” are among the most recommended policy interventions for such regions. Not last, for those regions where none of the innovation actors are prominent, featuring the broad-based innovation concept is recommended, with a focus on upgrading existing technologies and looking for opportunities in less research-intensive fields.

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MANAGEMENT OF NEW INNOVATIVE TECHNOLOGIES FOR DIGITAL TRANSFORMATION

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Abstract
The objective of this study is to assess how and in what way implementation of digital transformation improves the work process in the public sector of North Macedonia. The aims were achieved with analysing an empirical example of public e-service development, that is the courts in the Republic of North Macedonia.
The study indicates that with the implementation of digital transformation technologies, the main improvement is in the electronic connectivity. The results indicate that the can be observed in individual and organizational contexts. In terms of individual contexts, the time for input, processing, searching for documents. Regarding

organizational contexts, improvement refers to the use of technologies that reflects the organization's approach to continuous workflow, efficiency and productivity.

Keywords
Digital Transformation, Digitalization, New Technologies for Digital Transformation, Public Sector

1. Introduction

Organisations see digital transformation as a process that affects technologies, products and processes, rather than as a fundamental strategic change that requires sustained business development and repositioning in the business environment [1]. The key aspects for implementing a digital strategy are the perceptions and changes in how organisations operate [2]. The use of new digital technologies often implies fundamental changes in value creation models, which can result in completely new interactive system architectures [3].

Digitalization and communication technology can significantly increase the availability of information to society by simplifying the application procedures, the availability of the information, time required for data processing, and facilitating their comprehensibility. These aspects are very important in reducing the gap between the processes of the public sector and end user experience of such processes [1,4].

2. Digitalization as worldwide paradigm and phenomena

In the 2000s' companies were looking at data mining, search technologies and virtual collaboration technologies [4]. Today, technologies range from but not limited to: cloud, artificial intelligence, machine learning, 5G and internet of things, quantum computing, nanotechnology, 3D printing, fully autonomous vehicles, smart homes and smart cities [1,4].

2.2. Digitalization in Public Services

Digital transformation in public sector is equivalent to strategic use of technologies and data with a purpose of delivering public value [5,6]. Institutions and individuals responsible for administration in public sector in great number of countries in the world turn more and more to digitalization and new technologies with a goal of improvement of efficiency and access to information for the end users [1,4,5,6].

2.3. Digitalization in the Republic of North Macedonia

In 2010 The Republic of North Macedonia published its eGovernment strategy 'National E-Government Strategy 2010 – 2012'. It sets out a to stimulate conditions through aggressive introduction and massive efficient use of electronic communications and information technologies. The main purpose was to overcome challenges such as paper indexes, availability, access to data, use of electronic documents and low level of their connection to information infrastructures [7].

3. Implementation of Digitalization and Outcomes

The study demonstrates a digital solution established for the 34 Courts on the territory of the Republic of North Macedonia. The solution combines information technologies such as servers, storage device, virtualization and other technologies, in an integrated, tested, and optimized environment on a private cloud. The implemented solution is depicted on Figure 1.

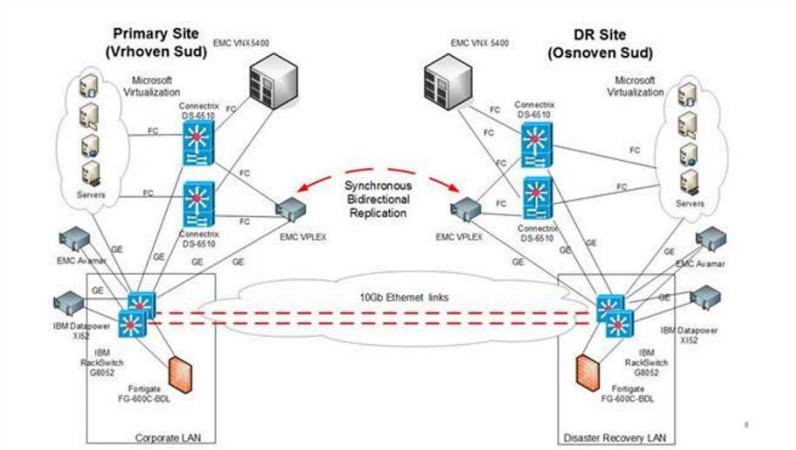

Figure 1 System Architecture of the Solution

The design of the architecture comprises of conceptual, logical and physical attributes of the Infrastructure-as-a-Service (IAAS). Cloud Service model and provides solutions to many of today's weak points in operation.

With the implementation of the digital solution several improvements have been accomplished including a Web presentation of the Courts via a single portal, Common design for each Court with different images, data and content, choosing a Court through the main page, Automatic publication of judicial court decisions, Automatic anonymization of published personal data in the judicial court decisions, Collaboration module and Integration with existing Automated Court Case Management Information System (ACCMIS), Indexing of judicial court decisions for easier searching, Reviews for searches of court decisions on various criteria. The search engine is shown in Figure 2.

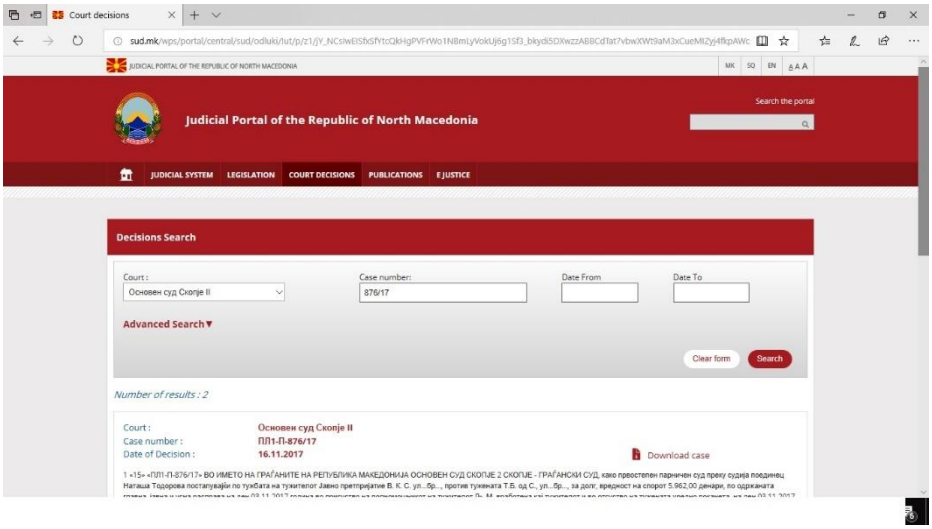

Figure 2 Search engine with anonymised court decision output

Delivered system also provides an interconnectivity between Courts and Public Prosecution Offices. This interconnectivity system has characteristics such as Exchange of documents produced from ACCMIS and Public Prosecution Office Case Management System (PPOCMS), Exchange of metadata for the documents exchanged and Interconnection via secured web services.

4. Conclusions

In this paper we discuss digital enabled transformation in the public sector in the Republic of North Macedonia. Based on an empirical example from the Macedonian context, we illustrate and discuss the process of digital transformation, the effects of the process, and the way in which digital transformation improves performance. There are multiple benefits of introducing one such system, and they all contribute to increased resources efficiency, standardization, sharing and collaboration.

In aspect of increased resources efficiency, the availability of electronic templates like in the digital solution for the courts of the North Macedonia means elimination of repetitive tasks, productivity increase and reduction of unnecessary workloads. When it comes to standardization, the digital solution for the courts of the North Macedonia offers consolidated electronic forms, work documents, templates and procedures. The central database or documents and information storage ensures sharing of documents from distributed locations to all concerned users, which stimulates collaborative processes and functional integration. In this aspect, availability of all data 24/7 from any location means reduced times to find, send and receive documents. From the study and in the academic literature [3] for this field it is obvious that implementation of digitalization represents fundamental change in the way that organizations function.

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MODELLING THE INNOVATIVENESS OF MICRO AND SMALL ENTERPRISES

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Abstract
Innovation is vital for firm's sustainability in today's competitive business environment. Although the innovation is widely examined in the literature, further research is needed in this field to address which factors determine the innovativeness of micro and small enterprises. The purpose of this study is to develop an integrated model of factors that influence the innovativeness through mapping factors often discussed in the relevant literature, that determine the innovativeness of micro and small enterprises. The conceptual model developed based on these findings is assessed through structured interviews of 18 experts from different stakeholders in the innovation ecosystem. The model, analyses two groups of factors: influencing factors – supporting innovation and influenced factors. The model which support micro and small enterprises to understand their innovativeness, is assessed and refined by 18 experts. The results outline that the corporate culture, especially the openness of the company, and the internal procedures and regulations for encouraging employees to innovation and acceptance of failure are the most dominant and important for increasing the innovativeness of micro and small companies. The refined model will serve as a basis for development of analytical tool to examine regional and national contexts in the further research.

Keywords
Innovation management, Innovation of SMEs, Factors of innovativeness, Measuring innovativeness, Innovation ecosystem.

1. Introduction

In this century, innovations are recognized as the main driving force in the knowledge-based economies. Increasing attention has been paid to the developing economies that undertake strategic actions that transit to innovation-led societies. Innovations are considered to be one of the most progressive determinants of socioeconomic growth, both in regional and local perspective [1]. The huge advantage of growth rates of certain countries, which is result of economic growth over longer period, is attributed to the presence of social capability for institutional change, especially if the change facilitates or stimulates technical change such as innovation systems [2]. The challenge of regional innovativeness as a specific process becomes more important to the regional and structural policy and to the EU. High levels of innovativeness have a positive influence on performance at the firm level [3] and, as a result, on economic performance at the regional or national levels as well [4].

The importance of micro, small and medium sized enterprises (SMEs) for the economic growth of every country is widely acknowledged. There is no shortage of literature and research studies that observe different aspects of the SMEs. The state models of many former socialist countries, such as North Macedonia, resemble to the triple helix, where the state has a governing role in the collaboration between the three main spheres of the society [5], [6]. Therefore, when researching the development of the innovations in companies, the specific socio–economic conditions needs to be taken into account. In this respect, this research makes significant contribution to the existing literature by collecting and analysing the experience of relevant experts from different professional and geographical background.

This paper is structured as follows. The second section presents the theoretical background and review of relevant literature on factors that influence innovativeness in companies. The third section explains the methodology,

outlining the conceptual model and the method for assessment and selection of the most influential factors. The conceptual model is consisted of an indicative list of factors that determine the innovativeness of companies, which should be reduced through structured interviewing process with a number of selected experts from the relevant scientific fields. The findings are discussed in the following section, in respect to the other similar cases from the literature. And finally, the last section concludes the paper, outlines the theoretical and practical contributions and discusses the directions for further research in this area.

2. LITERATURE REVIEW

Innovation refers to all scientific, technological, organizational, financial and commercial activities which lead to, or are intended to lead to the implementation of technologically new or improved products or services [7]. In general, firm innovativeness refers to firm receptivity and willingness to adopt new ideas that lead to the development and launch of new products [8]. The innovations that are introduced to the firms can be perceived and assessed by estimating the perception of the managerial team, the level of innovativeness and the alignment of the innovation intentions with the corporate core competences, as well as the variety of introduced innovations, patents and other forms of intellectual properties. The direct impact of innovations in growth of the companies could be identified by monitoring the progress in profit and turnover.

Previous literature has tried to identify the factors that drive innovation in the companies. The beneficial outcome of SMEs' innovativeness has been widely researched, but literature and empirical studies about factors that foster innovation remain scarce. The factors that influence the innovativeness in companies, especially among SMEs, are of crucial importance in this study. In order to provide comprehensive view of the relevant factors, we determined two broad factor categories that should be investigated: (I) Entrepreneurial attitude and internal ecosystem, and (II) Innovation process. These two categories are further divided on three (A. Overall setting; B. Culture; and C. Knowledge management) and two (D. Collaborations and external support; and E. Procedures and regulations) factor sub-groups respectively.

2.1 Entrepreneurial attitude and internal ecosystem

The number of general factors largely affect the innovativeness in enterprises, such as: the main sector of operation, the geographic market that is targeted, the strategic planning within the company and its corporate success, estimated through the financial results, growth in portfolios and growth in number of employees, as well as the environmental impact. Many studies have shown that the culture of the company is one of the most important factors for innovativeness. Empirical studies have largely found that firms with a higher degree of entrepreneurial orientation perform better [9], [10]. Entrepreneurial orientation in smaller firms (start-ups and SMEs) significantly originates from the owner's profile. It is discussed that openness to change influences the way how early ideas for innovations are screened and approached within the company [11]. Aloulou and Fayolle [12] consider "especially organizational culture, the nature of its climate and its practices of management" as a central antecedent of entrepreneurial orientation. Also the alignment of the professional competences of the employees with the corporate entrepreneurial practices is largely discussed [13].

Some studies present the relationship between organizational culture and rates of innovation [14], [15], measuring the impact of national culture [16], [17] or investigating the impact of a certain form of organizational culture [18], [19].

When it comes to the openness in the companies, the open innovation principles are largely discussed. Open innovation describes a cognitive framework for a firm's strategy to profit from innovation [20]. It proposes that firms should purposively use inflows and outflows of knowledge to accelerate internal innovation, and to expand markets for external use of innovation, respectively [21].

In a contemporary economy the competitive advantage has shifted from material and financial to intangible and nonfinancial assets. As Edvinsson [22] stated, knowledge has become the key source of wealth not only at organizational but also at national level. Knowledge based theory of the firm considers knowledge as the most strategically significant resource of the firm [23]. Its proponents argue that as knowledge-based resources are usually difficult to imitate and socially complex, these diverse knowledge bases and capabilities within the firms are the major determinants of sustained competitive advantage and superior firm performance [24]. Firms that are able to develop, manage and transfer this knowledge are more likely to gain sustained competitive advantage in the long run [23]. Therefore, each of the separate knowledge management processes, such as acquisition, dissemination and diversification, should be considered in this regard. This knowledge is embedded and carried through multiple entities including organizational culture and identity, policies, routines, documents, systems, and employees [24]. Particular emphasize is put on the continuous professional development of the employees for maintaining and extending their knowledge and skills.

2.2 Innovation process

The way of management and the execution of the innovation process within the company is developing the company's innovativeness. This process is affected by principles for collaboration with external partners on one hand, and the procedures and regulations for managing the innovations internally, on the other. Given that the aim of innovation is to offer superior value for customers in terms of new products and services [25], it may be

wise for SMEs to establish closer relationships with larger customers for the purpose of innovation [26], [27]. Collaboration with suppliers and customers has great impact on innovativeness; this effect is stronger for medium-sized firms than for small ones [28]. In addition, collaboration with research institutes and universities is positive for innovation [29], [30].

Prior research suggests that high-technology SMEs competing in international B2B markets can benefit from engaging in open innovation. SMEs generally lack the necessary resources to innovate and commercialize their technology. Therefore, engaging in collaboration for open innovation with larger customers can be a way to stay ahead of global competition. However, SMEs are also likely to face great challenges in establishing and maintaining external relationships, such as building long-term trusting relationships with collaboration partners [31].

Monetary incentives frequently are suggested as a method for motivating and improving the performance of persons who use and are affected by accounting in formation (e.g. [32]), and their use in organizations is increasing [33]. That said, recent research in accounting suggests that monetary incentives may reduce intrinsic motivation (effort) and performance on tasks viewed as attractive and that require some level of creativity or innovation [34]. More research is clearly needed, though, to sort out the relations among incentives, task attractiveness, intrinsic motivation, effort, and performance.

When it comes to the external financial support, broad body of literature confirms that majority of SMEs solely rely on their internal financial resources [35], [36], [37]. However, in the case of innovative SMEs, internal resources may not always suffice to finance and commercialise the innovation projects and firms end up having to look for external finance. Yet, these firms are hit by significant market imperfections when applying for external finance due to three well-known reasons [38], [39]: firstly, innovation projects are often lengthy, risky and the returns are uncertain with a highly skewed distribution. Secondly, information asymmetries characterise innovation projects, as the investor is often unable to fully evaluate the merit and potential of the project. Finally, small innovative firms make majority of their investments in intangible knowledge-based assets and, therefore, lack the tangible collateral that can be secured against debt to signal lower risk to investors.

3. METHODOLOGY AND DEVELOPMENT OF THE CONCEPTUAL MODEL

The methodology is composed of two phases. The first phase focuses on selection of the wide set of relevant factors for innovativeness for micro and small enterprises, identified throughout the analysed relevant literature. The model and the proposed interviewing process was piloted with two relevant academic experts (one from North Macedonia and one foreign) in order to assure that the chosen factors and their respective descriptions are clear, precise and detailed enough. The selected factors compose the conceptual model presented on Figure 1 that summarises our research interests and objectives.

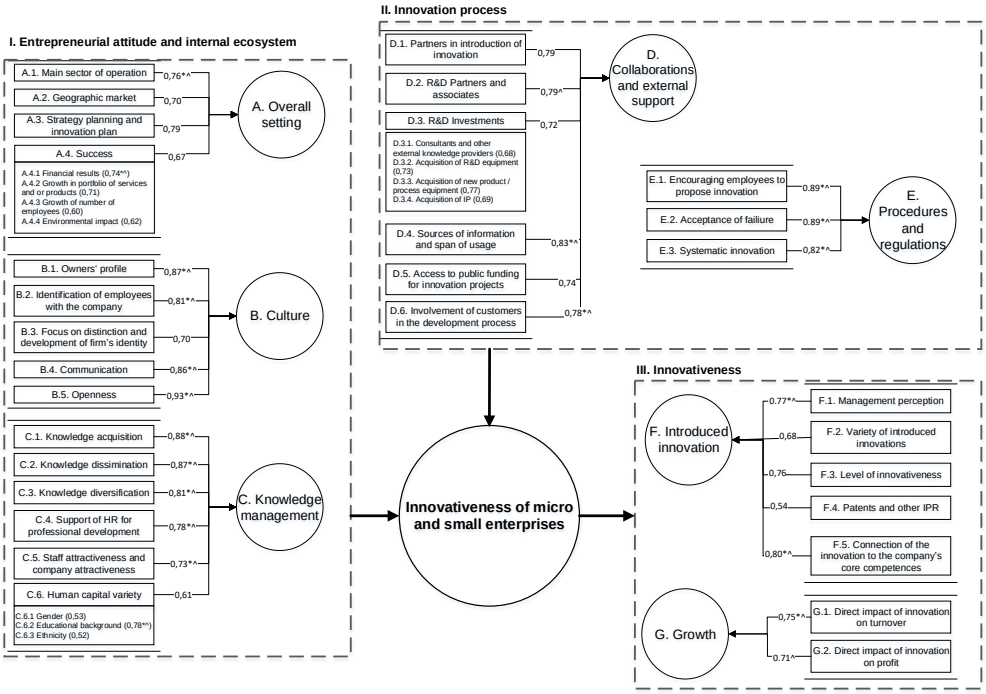

Figure 1. Conceptual model of the factors for innovativeness of micro and small enterprises

The second phase evaluates the proposed model through 18 structured interviews conducted with experts in the period summer - autumn 2016. The experts have been clustered in three professional categories: (1) Academia, (2) Business support organisations (BSO) and (3) Entrepreneurs in two geographic categories: (1) North Macedonia and (2) foreign. All identified experts from academia and BSO fulfil the strict entry criteria: topic – expertise in the area of innovation of micro and small companies; experience – more than 10 years' related experience; and education – second cycle higher education (master) or higher. For the entrepreneurs the education was taken into consideration, but with first cycle higher education (bachelor) as a minimum. The additional criteria were focused on the company(ies) established and managed by the experts: assuring it is clearly recognised as an innovative company and choosing at least one micro and one small company (co)owner in North Macedonia and abroad.

All experts were directly contacted and individual face-to-face interviews were conducted. During the interviews all factors were elaborated to the experts and they were asked to grade the relevance of each factor with a grade within the scale 1 (not relevant at all) to 5 (indispensable), adding relevant comments. Additionally, each expert was offered to add a missing factor in each sub-category. Each proposal was discussed with the expert and where it was determined that it is relevant and is not described by other factor, if supported by literature it was added to the list. At the end, the experts were informed about the results and were asked to rate the newly added factors.

The interviews with the experts provided deeper understanding of the relation of each of the factors to the innovativeness of micro and small enterprises. However, in order to structure the result and to quantify the selection of factors a system was set, measuring the following aspects:

1. Level of consensus

For each of the indicators the 18 answers were analysed and each of them which had standard deviation <1, was evaluated as a factor with high level of consensus (in the model fig. 1 and 2 marked with asterisk "*"). In order to have control over the extreme values, the factors which have not been graded with the lowest grade by none of the experts, have been additionally marked ("^").

2. Significance

For more clear presentation the grades have been converted in relative numbers (0-1). The factors with average value ≥0,75 were marked as highly significant and presented in Figure 1.

4. RESULTS AND DISCUSSION

This section discusses the empirical findings from the research and outlines the theoretical and practical conclusions. In addition, the first three most influential factors for innovativeness are widely discussed in respect to the relevant literature, as well as the specific national context.

According to the experts' opinions, the factors with significant importance for the innovativeness in micro and small enterprises that were selected with consensus are given in the Figure 2. This refined model has filtered out many of the factors within the group A. Overall setting, emphasizing the factor A1. Main sector of operation as the most important from this group. Indeed, different industrial and technological sectors determine the innovativeness of companies, as evidenced in many recent studies [40], [41].

The group of Knowledge management factors is the most dominant, represented with six factors in the refined model. The knowledge management refers to the application of collective knowledge to achieve the goals and the objectives of an organisation. The processes for managing the knowledge are essential in the modern, knowledge-based economies. These processes are moved to the focus with the expansion of knowledge-intensive industries where organisations deliver products and services relying on different types of knowledge [42].

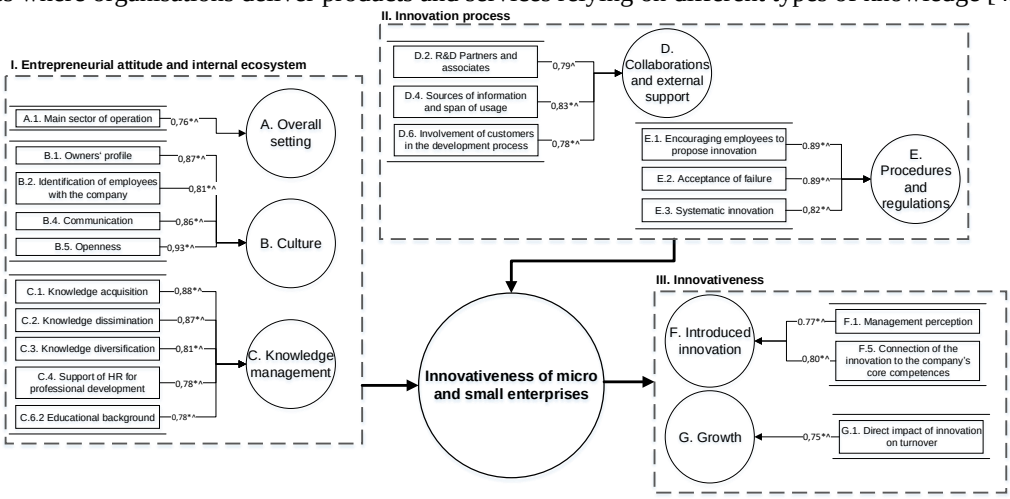

Figure 2. Refined model of significantly important factors for innovativeness for micro and small enterprises

The average grade of the selected factors within the groups Culture and Procedures and regulations is 0.88, which is the highest assessment among the discussed groups of factors. The Culture within the company, represented by the owners' profile; Identification of employees with the company; Communication and Openness, plays important role for the corporate innovativeness, as underlined also in numerous studies [12]. The corporate culture in respect to the innovations in the context of small businesses is often related to the entrepreneurial orientation of the owners/CEOs [12]. To define the concept of entrepreneurial orientation, [43] uses the findings from [44] to put his label on this construct as: The owner/CEO's strategic orientation reflecting the willingness of a firm to engage in entrepreneurial behaviour.

The three factors that were selected by the experts as the most important for the innovativeness in micro and small enterprises are the following: B5. Openness; E1. Encouraging employees to propose innovation; and E2. Acceptance of failure, marked with 0.93, 0.89 and 0.89 respectfully.

5. CONCLUSION AND IMPLICATIONS

This paper aimed to analyse the innovation literature and to select a variety of different factors important for increasing the innovativeness in micro and small enterprises. The identified innovation factors were arranged in conceptual model of innovativeness, which was assessed by the 18 experts from the area of innovation and entrepreneurship, representing one of the three professional categories: academia; Business support organisations; and Entrepreneurs. The gathered data from the experts was analysed, and overall assessment for each of the factors for innovativeness of the conceptual model was produced. The factors where consensus by the experts was not achieved, or that were assessed below 0.75, were filtered out of the model. The refined conceptual model will be subject to further quantitative research with a sample of selected micro and small enterprises. As part of the further development of this research, it is planned the selected factors of the refined model to be elaborated through sets of single and multiple answers multiple choice questions that will be additionally conducted to a chosen sample of 300 micro and small companies in the Northeast Region of North Macedonia and the Kyustendil district in Bulgaria.

The results from the experts' assessment presented with the refined model point out that the most numerous factors for innovativeness for micro and small enterprises are those within the group of knowledge management, which could indicate the great importance of knowledge for collaborative innovations in the corporations, but also these factors should be considered carefully in the case of micro and small enterprises in the further investigation, due to their limited capacities and resources. On the other hand, the groups of factors assessed by the experts with the highest average grade are Culture and Procedures and regulations. Moreover, within the group of factors about Culture is the factor Openness, which is the highest marked factor for innovativeness overall. This conclusion in the context of open innovation emphasizes the importance of using not only internal, but also external sources for knowledge and ideas for innovation, as a way for smaller companies to stay ahead of global competition.

This research is important for several reasons. The theoretical contribution of the results is very valuable for the researchers investigating the innovation in developing economies, due to the scarce available literature. The findings have practical implications for the managers in the companies in planning the strategic steps for becoming more innovative, which is the key precondition for success. For the policymakers from the region it is of an importance in creating effective polices and measures for enhancing the innovativeness of the industrial sector, especially for the SMEs.

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PUTTING TRIPLE HELIX INTO ACTION: EVIDENCE FROM SERBIA

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Abstract
Improving the cooperation of the three Triple Helix pillars is always a challenging task, especially in the developing economies. Literature review shows that there are various ways for developing cooperation of the Triple Helix actors. In this paper, the authors present a novel approach to a successful cooperation of Triple Helix actors that originates from a Serbian university. The presented tool is a global students' case study competition that gathers university, business, and government. The results provided by the *Champions Trophy 2020* methodology confirm that this case study competition is recognized as one of the top 10 global competitions in the world. More importantly, this is the competition among the ranked that is organized by an university from a developing country and also the only one that involves government. The purpose of this paper is to present a students' case study competition as an unconventional approach for building the Triple Helix society driven by entrepreneurial university. This paper shows that even in developing economies, universities can drive the cooperation of the relevant institutions and be the initiators of an integrated society.

Keywords
Entrepreneurial University, Case Study Competition, Developing Countries

1. Introduction

The cooperation of academia, business and government is important for creating a sustainable innovation ecosystem. Etzkowitz states that the Triple Helix is a "platform for 'institution formation'" that create new organizational formats for promoting innovation, as a synthesis of elements of the triple helix" [1]. Improving the cooperation of the three Triple Helix pillars is always a challenging task, especially in the developing economies. It has been identified that these countries have poor communication and lack of information about the possible form of the cooperation between the TH pillars [2]. Thus, it is important to recognize motives and tools for new success stories.

Entrepreneurial university is a crucial factor for "triplehelixising" an ecosystem, but this is a very challenging task since universities are not easy to be transformed. It is important to explore tools for developing practical

skills in formal education in order to foster innovation, apply knowledge and build employability skills for students. However, a lot of universities in their strategic mission prioritize research contribution rather than educational value for students that prepare them for their career path [3]. Focus of entrepreneurial university is shifting from traditional academic orientation to enablers of knowledge and innovation [4]. In this process, it is important to create students with practical knowledge, innovative approaches to concrete problems and adequate skills that meet market requirements.

The aim of this research paper is to present a students' case study competition as an unconventional approach for building the Triple Helix society driven by entrepreneurial university. The authors present a novel approach for developing the cooperation of the three main Triple Helix pillars and explain it on the example of a Serbian university. The quality of the competition is proven on the global ranking provided by the *Champions Trophy 2020* methodology that ranks this competition as one of the top 10 worldwide.

The authors examined existing Triple Helix instruments and present the review in the Section 2. In the Section 3 the global student business case study competition concept is explained, and the Champions Trophy 2020 methodology is given in the Section 4. The Triple Helix approach in the global case study competition is shown on the example of the Belgrade Business International Case Competition in the Section 5. Finally, the conlusions are given in the Section 6.

2. Triple Helix tools

Triple Helix model of innovation is important for both developed and developing economies. However, the challenges they are coping with are different. Developed economies mostly deal with the improvement of the existing infrastructure and explore how they can enhance the collaboration of the institutions. Challenges for developing countries are more focused on connecting the actors and raising the awareness about the importance and benefits of this collaboration, exploring the possible tools that are suitable for their environment. The primarily teaching role of university with low level of entrepreneurial activity is a big constraint for "triplehelixising" the national innovation system [5].

Research and development activities that result with scientific papers, spin-offs, patents and licences are identified as the main tools for the cooperation of Triple Helix actors in most papers [6], [7]. Also, strategic partnerships, consulting services, partnerships with startups, ventures, and venture capitals are recognized as a successful practice towards entrepreneurial university [1], [8]. Science and industrial parks, agencies, technology transfer offices, research centres and consensus spaces (virtual platforms for Triple Helix actors' discussions, brainstorming and evaluations), have also been recognized as successful models that foster these partnerships [1], [2], [9].

Although there is an exceptional list of the models of cooperation between Triple Helix actors, student business case study competition has not yet been identified as one. This is an unconventional approach, and, in Serbia, it is oriented on solving concrete practical problems from industry or governmental bodies. The model completely supports Triple Helix model and the concept of entrepreneurial university since the push and initiative for cooperation comes from the academia. Moreover, this is a bottom-up approach, where students directly engage in the cooperation activities and the model is scalable for any university or faculty at the global level.

3. Global Student Business Case Study Competition

Student business case competitions are considered important in developing a real-life format to solve organizational or managerial problems in an intense competitive environment. This type of solving practical problems helps students to develop skills for creative problem solving and also leads to achieving a higher level of entrepreneurial university. In the previous section, we presented various recognized approaches for developing the cooperation of the Triple Helix pillars. Still, case study competition has not yet been identified as an effective method that can enhance this cooperation.

To start, we will briefly explain the structure and the process of the business international case competitions for undergraduate students. Each school that is invited by the Host University to participate in the competition provides a team of four students from a business school. Students are specialized in different background: marketing, finance, accounting, economics, information technology, engineering, business law, and international business. Besides students, each team has a case advisor who is a member of university staff or a practitioner. The role of the case advisor is to select the team, create the student team and prepare them for competitions [10]. At the competition, each team needs to create and present a case solution in front of a jury consisting of practitioners from industry or government – the top management level, business consultants and/or government representatives. The process of the case analysis and presentation consist of the following phases: students are given a case or cases that they have not seen before and are sequestered in a room for limited hours; jury panel evaluates team solutions for 15 or 20 minutes of presentation and 10 or 15 minutes of Q&A session. Jury panel evaluates: content, presentation skills and Q&A part. All presentations are delivered in English language. Feedback by the jury is very important both for students and advisors, as it points to the strengths and weaknesses of each team. It is important to point out that members of the jury can have different perspectives coming from different sectors, which also means looking at a complete picture of solving a business problem. Top three

winning universities are chosen out of 12 to 24 participating schools. Participants come from different continents with the aim of encompassing geographical diversity.

3. Research method and findings

Champions Trophy 2020 methodology developed by Auckland University is used for ranking the international business case study competitions (with invitation only). Auckland University is responsible for selecting and ranking of the ten best organized case competitions in the world, using their methodology. An on-line quantitative survey was undertaken in November 2018 with 40 mentors who attended international business undergraduate case competitions from leading universities all around the world. The top 10 best international business case competitions for 2019 (based on results from 2018) are presented in the Table 1. Mentors selected three from Europe (Serbia, Denmark and Netherland), three from Asia (Hong Kong, Singapore and Thailand), two from North America (Canada) and two from Australia and Oceania (Australia and New Zealand). What is common to all 10 competitions regardless of the format and number of case studies is that all case studies are from an actual company (not published).

Table 1. Top 10 business international case competition for 2019 – mentors' perspective

Name of the international case competition	Country	Number of cases	Number of teams
Europe			
Belgrade Business International Case Competition	Serbia	3	20
CBS Case Competition	Denmark	1	12
International Case Competition @ Maastricht	Netherland	3	16
Australia and Oceania			
Australian Universities Business Case Competition	Australia	3	16
Champions Trophy Case Competition	New Zealand	4	12
North America			
John Molson Undergraduate Case Competition	Canada	4	24
Sauder Summit International Case Competition	Canada	3	16
Asia			
HKUST International Case Competition	Hong Kong	1	18
NUS Case Competition	Singapore	Secret format	16
Thammasat Undergraduate Case Competition	Thailand	1	20

Mentors also ranked the criteria used for selection of competitions. Results showed that quality of the cases (95%), quality of jury panel (85%), and quality of team presenting (70%) are the most important and relevant for choosing the best international case competitions. Importance of other criteria used for evaluation are: reputation of the host university (40%), number of cases teams present (37.5%), execution of case days (37.5%), number of teams competing (22.5%) and social networking opportunities (20%). Furthermore, organizer factors like length of competition (17.50%), accommodation (15%) and social activity (12.50%) are considered less important.

Here we should to emphasize that all competitions strive to be on this list. What is also very specific, the Belgrade Business International Case Competition is the only competition that provides cases from both industry and goverment, and Serbia is the only developing economy that is ranked on this list. In the next section we will present the Belgrade Business International Case Competition and show how it is possible to come to this list by nurturing and enhansing collaboration of TH actors.

5. Student Business Case Study Triple Helix model: BBICC example

The BBICC is a global case study competition organized at University of Belgrade, Serbia. Organizing committee of professors, assistant and students organizes the competition that has a rising reputation in Serbian business environment and global academic institutions. There are different teams responsible for organizing this

project (i.e. marketing team, external relation team responsible for partnership and fundraising, international affairs team, business case team responsible for case writing and organizing jury panel, etc.). In organizing committee, the leading roles have managing directors (students' co-chairs) and executive board that includes staff from university. Special group of 20 students are host ambassadors taking care for 20 universities who participate at the case competition. The initial push in these activities comes from the academia (University of Belgrade). But, without the support of industry and governmental bodies the results and implications would remain on the theoretical domain.

5.1. University – industry collaboration

BBICC competition is supported by strategic partners: industry leading companies and government. In order to start the cooperation with the company, BBICC committee has a three-step proposal:

1. Creating consulting offer from university to the industry: give a proposal to a company to become strategic partner of BBICC event and provide an actual business case, as well as the jury panels from company representatives.
2. External financing: providing a new way of funding for university with company sponsorship deals.
3. Growing together: building stronger bond between university and company collaboration: recruitment and selection of the top talent students from university.

There are significant benefits for both university and industry as the result of this partnership and they are presented in the Table 2 and Table 3.

Table 2. Benefits for company to become case partner at global student case competitions

Benefits for a company to be case partner	Explanation	Participant
Innovative global ideas	Getting possible 20 innovative solutions from world top talented students – Best Practice from other countries	Top management and all departments
Recruitment and Selection of top talents	Access to talent base of local (40 students) and global undergraduate mindset (80 students' biographies)	Human Resource Department
Employment branding	Strong Public Relations Effects in media and link with Faculty no.1 in Serbia	Marketing and Public Relations Department
Networking opportunity	Company representatives will meet other leaders - top management level	Top management department

Table 3. Benefits for university to participate at global student case competitions

Benefits for universty	Explanation	Participant
Develop talent case competition course	Creating case competiiton course for top talent students – provide university possiblity to be attractive for leading companies	Top management, mentors, students
Acquiring practical knowledge from different industry and markets	Improving teaching practical knowledge Improving students practical knowlegde and managerial skills Creating database of real cases for educational purpose	Mentors, Students
Building international brand of university	Improved educational image Networking with other faculties – that also engage in student case competitions	Top management, mentors, students
Networking opporunities	Teachers have option to network with students, other faculties and company representatives. They can establish student exchange program globally	Mentors

5.2. University – Government collaboration

Although government role in the Triple Helix model is often recognized as a supportive and legislative one, BBICC recognizes active role of the government in this form of partnership. Namely, the Government of the Republic of Serbia has an active participation as a case study provider, where they deliver the concrete problems they are struggling with. With mentoring guidance from their professors, students solve these issues and propose novel solutions.

Table 4. Benefits for government to become case partner at global student case competitions

Benefits for government to be case partner	Explanation	Participant
Innovative global ideas	Getting possible 20 innovative solutions from world top talented students – possibility to use other country experience	Government of the Republic of Serbia
Communication with the Industry	Getting more active communication with industry representatives during the event and having the opportunity to hear their perspective of the proposed problem	Representatives of the Government
Responsible governance	Switching from strategic to operational level of governance, and including the society (university) in proposing the solutions to the existing problems	Representatives of the Government
Stakeholder engagement opportunity	Invite representative of Ministry of Education, Science and Technology Development, representatives of Embassy of university participants. Some Embassy also can be source for funding	Ministry of Education, Science and Technology Foreign Embassy representatives
Promoting country image	Prime Minister opens student case competition	Prime Minister Office

However, the participation of government is more than beneficial since it gives another perspective to the problem that is related to the possibility of the implementation of proposed solution and promotion of the active participation of the society in solving the real issues at the country level. Other benefits for government participation are listed in Table 4. The participation of the government representatives is not a usual part of the business case competitions, so this is a unique value provided by this competition, what was one of the reasons for achieving higher score on the Champions Trophy 2020 list.

5.3. Industry – government collaboration

BBICC jury panel has both industry and government representatives. They have the opportunity to evaluate student teams' solutions and provide feedback to them and their mentors. In this process, the representatives can discuss the proposed issues and solutions. These activities provide better understanding of different perspectives of the actors. In this way, there is the complete picture of the national innovation system and it provides sustainable solutions due to the participation of all interested parties. Also, an indirect benefit of this process is the active communication of the government and industry and possibility for the further enhancement of their relations.

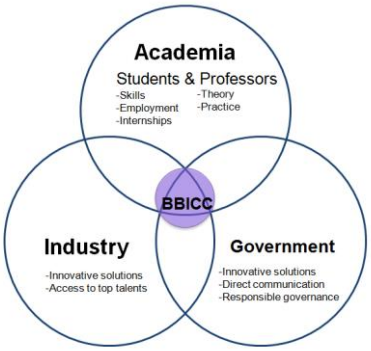

Figure 1. Triple Helix student business case competition model

The student business case competition model has benefits for all participants in the process of university–industry-government collaboration: for students it provide them opportunity to find easier internship or job within case partners, for professors who prepare students for competition it provide them link between theoretical and practical knowledge and for companies provide them innovative ideas and possibilities to hire the best students for best companies. Government also has its specific role that is related to the implementation of the solution, possible legislative issues, and strategy and policy implications, and they are direct stakeholders as they can provide case studies that need to have a fresh, innovative solution that originates from university perspective.

6. Conclusion

Putting the three main Triple Helix actors together is never an easy task, due to the complexity of their relations and scope of their activities. Thus, it is a challenging task to find novel approaches that foster this cooperation, especially in the developing countries. Traditional teaching role of the university has to be changed in order to foster creative thinking and problem-solving competences with students. Also, industry needs innovative solutions and novel approaches that originate from both students and professors. The role of government should not be neglected. Other than legislative role, it has to have better understanding of the actual problems and enhance communication with the actors of the ecosystem.

We presented a global case study competition as an innovative approach for building a Triple Helix society. We explained the main benefits for each actor and the steps that are necessary to conduct for the implementation of the competition. A global student case competition is a profitable and sustainable model for connecting all relevant actors of Triple Helix model. Moreover, it is a bottom-up approach that is easy to be implemented and it is scalable at any university and faculty level.

Developing economies face many challenges in operationalization of the Triple Helix concept. This story from Serbia, presents how universities can drive the cooperation of the relevant institutions by becoming more entrepreneurial. Students' case study competition has proven to be an effective tool for fostering the synergy between Triple Helix actors, with an initiative put by university.

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CLUSTERING BEACONS DATASET FOR TRACKING CONSUMER POSITION OF SMARTPHONE USERS

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Abstract
IoT has recently raised high awareness due to the automation of processes and the cost-effective implementation of different technologies for the shake of the technophile end-users. By comparing the positioning accuracy and the implementation effectiveness of different Proximity Services, Beacons seem to balance between a good quality of indoor approximation of users' location and a variety of options that constitute both cost effective and profitable Proximity Marketing propositions for early adopters-stakeholders of smart-businesses. Apart from the Marketing propositions that Beacons are offering though the BLE (Bluetooth Low Energy) they are offering a combination of reasonable indoor and outdoor accuracy techniques that ensure map navigation on both environments and put them on a leading position amongst the RFID (Radio Frequency Identification) technologies. Indoor Positioning Systems will play a key role on the Digital Transformation of Enterprises since they are offering great value to the stakeholders of businesses and to the potential customers. Machine Learning Algorithms seem to handle them effectively since they provide insightful indicators on both supervised and unsupervised learning. We implement an exploratory research on a pre-existing dataset taken from UCI Machine Learning Repository that includes Beacons measurements inside an academic library that will provide with insightful results for the visitors of the library.

Keywords
ioT, Proximity Services, Beacons, BLE, Hierarchical Clustering

1. Introduction

Through the modern times where technological advancements are breaking through, consumers and businesses need to adapt to the new ioT environment that contains state-of-the-art services and products and disruptive innovations. Customers, although they resist to change, they cannot bypass the positive effects that technology has to offer. [1] One relative field that is an upcoming topic on both entrepreneurial and research stream is the one that involves proximity services. Proximity Services have been around for the last century but some of them have been invented recently and brought attention worldwide. [2] Some of the are the Beacons which currently seems to balance between real time marketing solutions and a good approximation of end-users' positioning. Beacons Have been announced for the first time from Apple in 2013 and carry the protocol iBeacon.[3] Google has also invented the Beacons solution in 2015. Both two are utilizing the Bluetooth Low Energy technology but only Beacons are compatible with every single BLE device. With the technique called fingerprinting relative distance between a beacon and an active device can be calculated with a trust between 1-5 meters.[4] From the study of the marketing influence of a digital signance inside a retail store until the advent smartphone proximity services technologies and its influence on customer behavior proximity marketing and services have served, the potential of such services have raised high awareness for the potential that bring on the study of potential customers' buying behavior.[5]

2. Literature Review

The major smartphone sensor that can be utilized for map navigation is the GNSS antenna which in some bibliography can be met as GPS and offer at least 5 meters positioning accuracy for single frequency smartphones and a better than 1-meter accuracy for dual frequency smartphones. [6]

Hybrid Localization methodologies include the cooperation of Beacons with multiple access points of a Wi-Fi network for indoor positioning. Many approaches are referring to the potential of existing algorithms that can track effectively moving end-users with this method. [7] Others have differentiated themselves stating that indoor positioning problem has not been fully resolved with hybrid positioning and therefore there is room to grow concerning research and development of methods and technologies. [8]

BLE is an inseparable piece not only Beacons but on most of the IPS (Indoor Positioning Systems). BLE is coming with every single smartphone device since the update of 4.2 on Bluetooth sensors. This ensures that Beacons access is compatible with all smartphones as long as the end-user has downloaded the relative application, in order to communicate and give access to those devices. [9]

Beacons have been implemented through a variety of complex projects. One of them is as a driving assistant for car drivers that had the opportunity to know where are the empty parking spots and how they can approach them in their nearest area of interest. [10] Blind or vision impaired people can be fully benefited by projects that include Indoor and Outdoor Positioning with the use of a modified smartphone or similar device. There are

numerous researchers that have implemented innovative services that can utilize the BLE signal with a personalized voice assistant through specific equipment for the end-user that can guide people with special needs through big buildings such as malls and the like. [11]

On the tourism sector Beacons has been utilized in public transportation when it comes to railway stations. Tourists that don't always know the local language of the country that they visit can get a huge help from the fact that smartphone applications can cooperate with BLE technology and provide accurate mapping navigation in the language selection of the end user. This kind of assistance has increased the number of visitors that are landing into these areas as tourists. [12]

Personalized content can be applied to the visitors of a country that have to go through an airport for transportation. Big Airports are usually difficult to walk through and can cause stress and anxiety to the potential visitors that would like to visit a country. [13] Indoor navigation services are not still available with high precision since the GNSS antenna cannot provide a useful estimation of real time user's position. With the digitization of indoor maps of an airport, the installation of the relevant equipment inside the airport, and the development of a smartphone application airports seem to enhance travellers' experience since it provides with all the useful information that a flight attendant is searching for inside the airport.[14] It also seems to benefit the businesses that are running inside the airports and can notify nearby potential customers for their exclusive offers and coupons.

Location Based Services can benefit physical stores that are working on retail industry. This is happening with the use of auto check-in of the users that enter the physical store.[15] A welcome message can make a huge difference when it comes to the user experience of the visitor-customer. The visitor of the physical store has the opportunity to navigate inside the store and search for a specific kind of product without having to search and ask for an employee of the store.[16] They can also be combined with the NFC technology to provide useful information regarding specific products without the use of the internet. [17]

Big malls can also provide an excellent user experience since the installation of Beacons equipment and a smartphone application can provide useful information for visitors that want to find a specific store inside the mall. This implementation can make the difference especially in cases that competition has not the same services concerning indoor map navigation. [18]

Some researchers have clarified that Beacon-based implementations can monitor traffic inside big buildings in real time, hence pattern recognition regarding visitors' selected positions may apply as well.[19] This can occur under the umbrella of two main groups machine learning algorithms, the classification and the clustering. Due to the fact that the majority of the collected data are unlabelled they tend to be more useful after applying clustering algorithms. [20]

Publications have questioned the correlation between the RSSI and the distance that is unveiled behind the transmitted signal from beacons to the smartphones. The more far that these two devises are located the wider the differentiations that faced on these correlations. Sometimes it is difficult to certify whether an end-user is located in a pinpointed location or 2 meters further due to nature of BLE signal that leaves data open for more interpretation. [21]

For researches that are examining the response of end-users that are early adopters of these technologies additional aspects are having major roles into the evaluation of the process. For example, the usability of a mobile application is expected to give additional clues to the evaluation of the time of indoor navigation for the end-users. User interface needs to be clear on what the smartphone application is offering otherwise a project such as this is easily abandoned by users. [22]

An expected value regarding users is not isolated only into an indoor navigation, but also specific information for the nearby businesses for malls. A point system that is rewarding the end-users for their effort on using the application is providing successful attributes according to the businesses that have adopted such technologies. Gamification aspects are playing vital role into those processes and engage more users to interfere with these applications. [23]

Another area that is currently tested with the use of such technology is the real time marketing propositions available for marketeers. The implementation of those can raise high research interest for most of the cases since the responses of the smartphone applications trigger different positioning results for the end-users.[24]

Inside the physical store of an enterprise there can be measured indicators such as traffic, impressions of some products and bounce rate that were only existing until today in digital world.[25] So, a process of a digital transformation for a future company might include multiple procedures, and some of those might include the

installation of indoor positioning related equipment such as Beacons and monitor of customers real time positioning with related computer software. [26] Hence the future digital transformation for physical stores might include the rearrange of human resources in way that there will exist some sort of collaboration between the information systems of the company and the employees that are helping potential customers with their purchases inside the store.[27]

3. Research Methodology

For the purposes of this research we have utilized a Beacons dataset that was implemented in the Waldo library of Western Michigan University. This library has installed 13 iBeacons into their facilities in order to gather RSSI measurements from the users of the smartphones of the library. These measurements are indicating the existence of an end-user near the area of a specific iBeacon. In order the users to be able to interact with iBeacon devices they had downloaded the mobile application that was implemented for this purpose. [28]

The dataset contains 1420 instances that were processed through the clustering algorithm. The measurements were gathered through operational hours of the library. The RSSI have always negative value and can go from values near to zero until -200. The values that are near to zero indicate that the end-user is more near to the iBeacon than the one that is close to -200. When the value is -200 then that means that no user is near the iBeacon device. [29]

We have carefully studied the way that most of the clustering algorithms are working with an unlabelled datasets and the first algorithm that was excluded from our choices was k-means since it needs take in advance the number of the clusters that we need for our research and this was not viable for the purpose of our research.[29] We have selected an algorithm that can handle unlabelled data and by processing the dataset it chooses to cluster similar measurements into the same clusters. The algorithm is called Cobweb which is an incremental system for Hierarchical Conceptual Clustering that chooses itself the number the number of clusters according to the way that measurements are responding to the algorithm. [29]

Cobweb exploits datasets by using measurements as a classification tree. Each node in a classification tree represents a cluster and is labelled by a probabilistic concept that summarizes the attribute-value distributions of objects classified under the node. The 4 operations that Coweb algorithm uses are the following.

- Merging two nodes by creating a whole new node from the two pre-existing ones.
- Splitting a node into two separate new nodes.
- Inserting a new node
- Passing an object down to the hierarchy

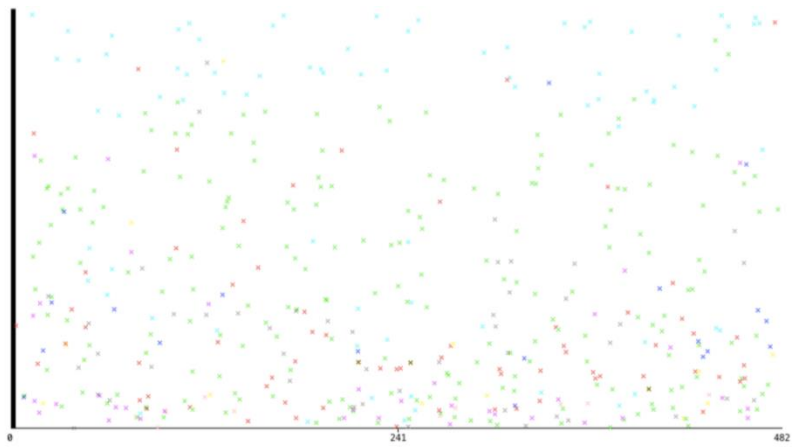

Figure 1 Visualization of Clustered Instances

From the implementation of the algorithm and the visualization of the cluster data we have verified the existence of 74 clusters, and we are going to examine the major clusters that qualify for further explanation and research on this dataset. The highest number of clustered instances contains 134 measurements and in the above picture they are layered as the blue dots. Next ones include 55 measurements and are labelled as the green ones. The third, fourth and fifth most significant clusters includes 12, 10 and 10 instances consecutively RSSI measurements.

Table 1 Clustered Instances

Clusters	Instances	Typical RSSI	Number of iBeacons per Instance
1	134	(-65) – (-100)	1
2	55	(-65) – (-100)	2
3	12	(-65) – (-100)	3
4	10	(-65) – (-100)	3
5	10	(-65) – (-100)	3

The RSSI values cannot be directly connected with distance metrics in way that is accurate enough for further research although there is a type connecting the distance between two ble devices and the distance between them, which occurs for the ideal scenarios where there is only space between them.

$RSSI = -(10n)\log10(d) + A$

Where d is the distance between a Beacon and a smartphone connected to the Beacon and A is the typical RSSI number that corresponds to 1 meter of distance between the smartphone and the Beacon. The "n" value is a metric that depends on the environment and the obstacles that are between the smartphone and the iBeacon each time. On the limitations of this paper is that we couldn't find the value A neither on the dataset description and guidance nor to the paper that was involved before us with this dataset. [30]

4. Conclusions and Research Discussion

While studying the measurements that were clustered in the same teams, we have found that this algorithm can deliver some interesting propositions. First and foremost, the first team that the algorithm separated includes mostly single iBeacon transited signal. The next cluster with 55 instances includes transmitted signal from 2 iBeacons for most of the cases and for the third with 12 instances the received signal is gathered from 3 iBeacons. The first two cases the location approximation of the end user can be implemented on the mobile application algorithm through the typical fingerprinting method. But for the 3rd cluster of instances apart from the prementioned technique the additional triangulation technique can be applied on those datasets. The combination of fingerprinting and triangulation can potentially provide with more accurate precisions on the matter indoor positioning, but on the usability of Proximity Marketing through Beacons nothing is changed.

It seems that most of the datasets created nowadays from RFID based technologies are unlabelled data. Those data seem can mostly be exploited with machine learning algorithms for pattern recognition purposes. Moreover, Clustering algorithms can reveal similarities on the instances of a dataset after the processing of the data. This becomes very useful since most clustering are offering optimal solutions for Beacons datasets and they don't ask for the number of clusters in advance, but they are finding out which number is the best applicable according to every case. An example of such an algorithm is Hierarchical Clustering which among other similar algorithms can highlight the most important Instances into large Clusters and leave the other smaller ones as complimentary material. The technologies that were mentioned on this research along with the data generated from businesses and Institutes are the key elements of a part of the Digital Transformation of the Businesses that has already began and include the Proximity Marketing.

Acknowledgments

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IMPROVING INNOVATION CAPACITY OF SMEs THROUGH CORPORATE ACCELERATION AND INCUBATION PROGRAMS COMBINED WITH OPEN INNOVATION PRACTICES

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Abstract
Development of the innovation capacity of SMEs builds upon the business's ability to pursue objectives such as a) the exploration of market needs, b) the exploitation of new business opportunities, and c) the ability to change and adapt to new market conditions while aligning operational strengths towards creating competitive advantage. A business ecosystem that fosters the Quadruple Helix relations and the growth of university – industry – government – citizens cooperation providing links to other regional, national, cross border and international business ecosystems, may improve the business's innovation potential. This paper is based on an Interreg IPA Cross Border Cooperation Project, *Corporate Acceleration for Existing Ventures*, which is a joint project that aims to improve the cross-border innovation capacity of business through mechanisms of corporate acceleration and incubation facilitated by open innovation practices. Within this project, the procedure of linking business ecosystems in order to improve business's innovation capacity implies the need for a joint co-creative process. This paper presents the research methodology, consisting of the project process itself. It discusses the creation of a supporting mechanism that joins efforts of various stakeholders in the cross-border area for increasing innovation capacity of businesses while creating job opportunities. The transferability of the identified approaches and the strategies for replication of the proposed mechanism are also outlined. Methods and tools used in the context of corporate acceleration and incubation programs combining open innovation actions may yield tangible results in the process of creating new products and services. Those programs need to be accessible by businesses operating both in urban but also in rural areas. In this context of democratizing entrepreneurship,

corporate acceleration and incubation programs can be delivered both physically but also virtually, providing the opportunity to access business support services remotely.

Keywords
Entrepreneurial Ecosystems, Quadruple Helix, Corporate Accelerator, virtual business incubator

1. Introduction

Supporting the continuation, sustainability and competitiveness of existing businesses can shape the innovation potential of linked business ecosystems [1]. In order to achieve this, supporting ecosystem mechanisms are the necessary means that may promote business's competitiveness through innovation as innovative models in the forms of collaborations can develop a business ecosystem so that more ideas can emerge, more job-creating companies can grow and more enterprises can achieve innovation and increase their competitiveness [2,3]. These mechanisms can facilitate business's survival and growth and may assist the preservation and also the creation of new job opportunities contributing to the economic recovery of areas that suffer from high unemployment rates and brain drain [4].

A joint co-creative process is required in linking business ecosystems in order to improve their business innovation capacity [5]. The process outlined in this paper implies the need to devise tools and methods that can: a) facilitate the understanding of business strengths, b) improve business skills through the share of knowledge and c) facilitate the identification of solutions in addressing market needs. The questions that are raised are how to achieve this and what processes, methods and tools can support it. Quadruple Helix relations and the growth of university – industry – government – citizens cooperation are providing links to other regional, national, cross border and international business ecosystems that may improve the business's innovation potential and turn it into growth.

2. Background

In March 2018, actors of the Quadruple Helix in the Cross Border Region of Greece and Albania i.e. the University of Western Macedonia, an academic institution and a public body (GR), the Tourism Organisation of Western Macedonia (WM), a regional development agency-governed by public law whose aim is to support and promote tourism in WM and communicate new prospects regarding tourism to the Regional Authorities of Western Macedonia (GR), the Centre for Development and Democratization of Institutions, a private organisation that networks the public sector with citizen communities (AL), the Chamber of Commerce and Industry of Gjirokaster, an organisation that has as members the local businesses (AL) and the Albanian Network for European Integration, a private non-profit organisation that promotes citizen engagement (AL) were awarded with funds for a joint development of a business ecosystem mechanism. This mechanism should be capable of promoting innovation and resilience of local businesses at the cross-border area and linking this ecosystem with other regional, national, cross border and international business ecosystems. The funds were awarded under the project "*Corporate Acceleration for Existing Ventures*, *ACCEL",* an Interreg IPA Cross Border Cooperation Project.

The Cross-Border region of Greece and Albania is challenged with: a) population decrease due to the brain drain phenomenon where highly educated people immigrate to other countries mainly in central Europe, seeking better career opportunities, and b) high unemployment rates. In Greece, youth unemployment rates reaches 43,6% while for Albania 24,5% [6,7].

The ACCEL project is designed in order to decrease in a short time the extremely high levels of unemployment in the cross-border (CB) area, and reverse tendencies of further unemployment increase, due to the long-lasting economic crisis and absence of job opportunities while creating a more resilient business ecosystem that can support business to grow. This will be achieved by supporting established businesses carrying out innovation projects with the contribution and help of Innovation Assistants. Innovation Assistants will be university graduates not currently employed. A holistic supporting acceleration and incubation program that includes training, coaching and mentoring will support businesses and their Innovation Assistants to carry out their innovation projects successfully, by testing and bringing the new products and/or services to the market. To this end, ACCEL incorporates an inclusive design using a holistic approach engaging graduates, established business, business support organizations, higher education and research organisations, and regional and local public authorities.

2.1 Scope and objectives

The scope of the ACCEL project is to increase innovation capacity and competitiveness of existing enterprises and link capabilities with real businesses' needs in the CB GR-AL area. This will be achieved through co-creating supportive actions that can exploit the current innovation potential in existing businesses and help transposing innovation into business opportunities that can consequently create employment opportunities.

3. Methods

The methods that will be used in achieving the aim of the project encompass the design of supportive tools and the implementation of supportive mechanisms as described in the following sections.

3.1 A Business Idea Diagnosis Tool

A Business Idea Diagnosis Tool will be designed to assess the business ideas, the team and the product innovation potential. The business idea diagnosis tool will provide an evaluation tool that will assign a score for each team/project and based on this score the teams will be promoted to the Business Accelerator program, or the Business Incubator directly or they will be referred with comments and suggestions on how to improve the initial idea and resubmit the concept.

3.1 V-XElerate

A virtual corporate accelerator "V-XElerate" will be designed. V-XElerate will be a 3-month intensive, unique and empowering entrepreneurship training and mentoring programme. V-XElerate curriculum will aim to ignite the prototyping and business modelling of feasible and marketable solutions in tourism i.e agrofood, ICT development, health-wellness business, operating in the CB region while simultaneously build multi-national teams capable of effectively working on a virtual environment i.e. linking business in the CB area with Innovation Assistants located in other areas. Business ideas will have the chance to grow within the acceleration program and business teams coupled with innovation assistants will be supported by experienced mentors and coaches. Training seminars will provide the theoretical knowledge basis for the development of the business ideas. Training seminars will cover the following topics: understanding and clarifying the core business concept, form an effective team, create, crash-test, assess and reassess of the business model, design the prototype product or service, research into the associated technologies, validate product and/or service, learn and refine pitching techniques, network and outreach, understand where and how to find funding sources.

3.2 V-CUB

A virtual incubator "V-CUB", free and open-to-the-public that envisages to 'democratise' entrepreneurship will be implemented. Business located far from urban areas can have access to training/mentoring/coaching while being matched with Innovation Assistants (well educated graduates) for carrying out innovation projects. Two (2) training cycles will be carried out on the following topics: IP issues including patents, trademarks, copyrights; public relations including branding, social media strategy, and authoring press releases; 3. legal business structure; 4. capital formation including grant writing, small business loans, seed capital through crowdfunding, investment banking, and pitching venture capital; 5. operational efficiency including lean principles, leasing real estate, project management; 6. sales & marketing training including import/export, internet marketing, & entrepreneurial marketing. All seminars will run physically once and will be recorded in order to be provided online through the Virtual Incubation Platform resources space.

3.3 Business internal training seminar

Business internal training seminar on how to encourage, support and manage innovation projects along with how to search for the right people with capacities to carry them out successfully, are envisaged for the participating companies. This will create the business conditions to attract well educated graduates work and live in the cross-border region.

3.4 Mentor's Network and Advisory Board

Business in the CB area can apply and have access to an international Mentor's Network and an Advisory Board made up of highly experienced entrepreneurs and professionals.

3.5 Strategic knowledge transfer and recommendations

A Policy Action Plan with policy recommendations on how to a) promote innovation and entrepreneurship in practice creating employment opportunities and b) better prepare graduates to deal with real tasks in real business will be prepared. This will foster stakeholder networking initiatives towards joining efforts for creating new jobs in the CB area.

ACCEL in its developments will also produce a Good Practice Guide with lessons learnt on how to run corporate accelerators and virtual incubators successfully and a mainstreaming guide that will include project results, outputs and links to accessible online resources developed by the project. Those strategic documents scope will be to promote mobility and co-operation of scientists in sectors of local economy, which can turn into profitable business and inform the decision-making bodies on potential strategic measures that could be incorporated

4. Expected Impact

With the proposed methodology ACCEL envisages to provide a holistic supporting mechanism that addresses the needs of the youth and unemployed educated people, and the existing business while helping the entrepreneurship ecosystem to grow. This is achieved for the different beneficiaries in the following ways:

For unemployed educated youth (as Innovation Assistants):

- Experience business in a practical format;
- Co-create new business opportunities that have a comparative advantage at a local and international level by developing new and innovative products and services

- Test the feasibility of real business challenges with the help of experienced entrepreneurs as mentors
- Develop entrepreneurial skills and the ability to recognize and pursue business opportunities in practice

For existing business to:

- Build competitive advantage through the innovation process of creating new products/services thus creating conditions that are attractive to funding either by the business itself or other sources of funding.
- Grow and create job opportunities for young educated people

For the entrepreneurship ecosystem to grow through:

- The creation of a supporting mechanism that joins efforts of various stakeholders in the cross-border area for increasing innovation and job opportunities in practice.
- Establishing connections among research and academic institutions and the productive basis in the cross-border area

5. Conclusions

The envisaged results of the project are to accelerate at least fifty established business and incubate 70 businesses in the CB area respectively. Through the ACCEL project, new job opportunities will be pursued through the realisation of a combination of practical supporting tools and mechanisms that shape a competitive business environment co-developing innovation projects. ACCEL beneficiaries will gain experience in managing innovations and addressing effectively market demands in practice while they will be supported by a professional network of mentors and coaches. The innovative element of ACCEL, apart from the combination of tools and mechanisms, is that it democratises entrepreneurship by supporting businesses virtually benefiting the whole CB area & providing hands on support to build new products and services.

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THE MULTIPLE HELIX MODEL AS A TOOL FOR SMART GROWTH

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Abstract

The authors analyse the studies on the factors influencing regional growth, their criteria at regional level. The importance of state institutions and regional government, that take responsibility for the results of smart growth at the regional levels, is essential. In addition, the new paradigm of regional growth focuses on creative, integrated and comprehensive growth with an emphasis on local assets and know-how. This paper aims to provide in-depth understanding of impact on ensuring competitiveness and smart growth at regional level with focus on place-based approach.

The quantitative assessment is based on the establishment and testing of the integrated index (Smart Growth Index). The qualitative assessment is based on the regional experts' opinions summarized by using the Analytic Hierarchy Process methodology. Theoretical and empirical research analysis was conducted as well as

summarising of international experience within the context of smart growth and place-based competitiveness, using measurable indicators and indices. Thus, the study has an interdisciplinary nature (economics, social aspects, governance) and a variety of research methods are applied to it. Finally, the main results are presented with special attention to governance indicators and its importance in smart growth progress. As a result of both the quantitative and qualitative evaluation the local people have been recognised as the main driving force of the local territories growth in Latgale region (Latvia). The research results have both scientific and practical applicability in promoting smart growth ~~in~~ at regional level.

Keywords
Dimensions of Smart Growth, Governance, Latgale region (Latvia), Multiple Helix Model, Regional Growth, Smart Specialisation (S3)

1. Introduction

One of the most important aspects of implementing the concept of smart specialisation is the participation of all stakeholders. The study stresses applying the multiple helix approach (emphasizing relationships between government, academic and commercial partners, society, media, NGO) on smart growth evaluation in the context of RIS3. The multiple helix is a way of conceptualising the involving key stakeholders, their roles, or functions, over time, and the relationships among the key operational elements. Nowadays a strong influence on growth processes in different levels has stakeholders' involvement in knowledge and technologies activation, that is a crucial element of smart governance system.

2. The Multiple Helix and regional growth

Based on the experience found in the scientific literature, the authors of the study consider that the view expressed in the context of the new development paradigm regarding the use of each territory's potential [15] also clearly highlights the potential of small local territories to engage in the process of smart specialization. By summing up the European and the USA experience in providing smart growth, [1] concludes that local territories also have plentiful opportunities to develop smart specialization and that the emphasis on specific indicators can only lead to a misunderstanding of local territories for their potential to be involved in this process. Smart regional growth as a multi-stakeholder ecosystem upholds the value co-creation process of related actors within a framework to provide optimal well-being standard.

The Smart Specialization Strategy prioritizes creating a competitive advantage by developing and adapting research and innovation to business requirements and market development in order to use the appearing opportunities in a coherent and successful way at the same time avoiding duplication and efforts fragmentation (Smart Specialisation Strategies, 2017, Rivža 2018, Territorial Impact., 2017). The OECD defines smart specialization as a set of approaches combining industrial, educational and innovation policies. It recommends for countries and regions to identify and select a limited number of priority areas for knowledge-based investment, focusing on their strong and comparative advantages.

This clearly emphasizes not only multi-stakeholder but also multidisciplinary approach to regional growth in the context of smart specialization. Smart specialization means, first of all, focusing on the comparative advantages of scientific, technological and economic specialization. Secondly, working out development policy with wisdom to identify spheres that have or will have comparative advantages. Thirdly, *ensuring well organised governance* to unite all the stakeholders' potential in the specialization strategy [11] [6].

One of the most important aspects of implementing the concept of smart specialisation is the participation of all involved actor [9], Using the Quadruple Helix Approach, EU, 2016, thus one of the solutions of smart growth evaluation is the multiple helix approach. The purpose of this paper is to analyse smart growth aspects in local territories by applying a multiple helix approach, emphasizing relationships between government, academic and commercial partners, society, media, NGOs. The multiple helix is a way of conceptualising the linkages between different actors and their roles, or functions, over time, and the relationships among the key operational elements in a regional development perspective [4] [5] [3]. The development and implementation of the concept of smart specialization at the local level require active process of clarification and discussion involving all interested parties. Furthermore, Multiple Helix has been identified as the reference approach for the preparation and implementation of the Research and Innovation Strategies for Smart Specialisation (RIS3) (RIS3 Guide EC, 2012, [6], [10]. Wider engagement of stakeholders as well as combining qualitative and quantitative methods provides more detailed and comprehensive approach in smart growth at regional and local level.

3. Research discussion and results

Nowadays the region's development is characterized by a paradigm shift involving analysis of regional growth taking into account the conditions of sustainable and smart growth, adapting them to the local context, highlighting existing opportunities rather than unfavorable conditions [17] [11] [2]. Multi stakeholder approach

was applied in the study to define different indicators describing the impact of the state, municipalities, citizens, and the EU on regional development and smart growth.
As a result, combining a multidisciplinary approach (see Fig 1), and multi-stakeholder view, we get a diverse network smart growth model for the region, which provides the opportunity to identify and develop multiple scenarios of smart territories.

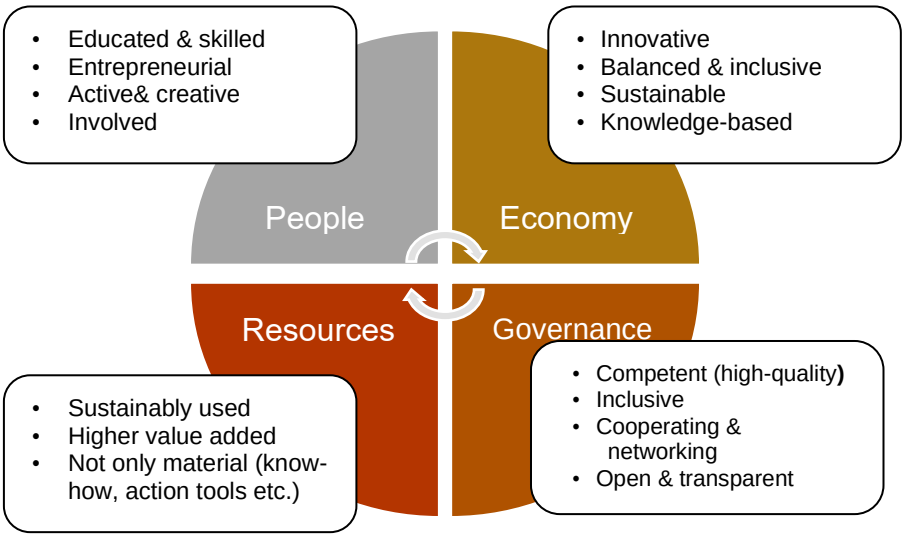

Figure 1 Dimensions of smart growth

The research results showed that wider engagement of stakeholders as well as combining different growth dimensions and including qualitative and quantitative methods provides a more detailed and comprehensive approach in smart growth.

The smart growth index, which includes all the necessary dimensions for the region development (resources, people, economy and governance), allows to identify new development directions of Latgale region. The values of correlation coefficients between the smart growth index and its dimensions show that there are different accents for smart growth in regions of Latvia. Moderate close and close correlation was found between the smart growth index and its dimensions *people* (r = 0.615), *resources* (r = 0.548) and *governance* (0.419) but likely insignificant correlation with dimension *economics* (0.218) (for more see [1]) It shows that *governance* performance is insufficiently reflected in the smart growth of Latgale region. Therefore, it is necessary to work on improvements.
The general trend demonstrates a significant dominance of *governance* dimension in Latgale region. On its own *smart governance* is a multi-modal ecosystem with active cooperation between different levels of government and modern tools, using modern technological and other solutions, to achieve timely response to the challenges facing the society, with the help of the latest scientific knowledge and the broad participation of the social partners in addressing topical political, socio-economic, public safety, etc. questions.

One of the most important aspects of governance is the motivations of local officials, their aspiration and the ability to involve the locals, namely the possibility of activating the hidden potential of the population (education, skills etc) for the well-being of individuals and for improving the region's competitiveness. The quantitative assessment of the smart growth index in the governance dimension (the value of the index in different territories of the region from -4.5 to 6.7) includes aspects of political participation, service quality evaluation, as well as work of administration:

• EU funding for development, EUR per 1000 people (indicator value in different territories of the region from -1.1 to 2.9)
• EU funding for agriculture, EUR 1000 per capita. (indicator value in different territories of the region from -0.8 to 2.7)
• Voter turnout,(%) (indicator value in different territories of the region from -1.9 to 2.1)
• Changes in the e-index, (%) (indicator value in different territories of the region from -1.5 to 2.4)
• Internet coverage, zones (indicator value in different territories of the region -0.7 to 3.4)

	Smart Resources	Smart People	Smart Economy	Smart Governance		Smart Growth Index
				Index	Cluster*	
Aglonas district	2.425	1.109	1.251	-0.665	2	4.120
Baltinavas district	2.108	-1.198	-4.729	6.677	1	2.857
Balvu district	-0.901	3.462	3.516	0.255	2	6.332
Ciblas district	-0.968	-1.023	-1.609	-1.358	3	-4.959
Dagdas district	-0.669	-1.035	2.687	-0.552	2	0.430
Daugavpils district	0.912	1.338	-2.719	0.067	2	-0.402
Ilūkstes district	0.841	2.227	0.853	3.465	4	7.386
Kārsavas district	1.879	-1.059	0.408	4.687	1	5.916
Krāslavas district	0.522	1.977	0.413	2.277	4	5.189
Līvānu district	-1.482	0.334	3.648	-0.208	2	2.292
Ludzas district	-1.461	2.479	0.087	-2.836	3	-1.731
Preiļu district	0.367	5.161	0.525	-0.052	2	6.002
Rēzeknes district	2.069	0.232	-2.820	1.872	4	1.353
Riebiņu district	0.058	-4.704	0.494	3.682	4	-0.470
Rugāju district	0.109	-1.082	-2.348	1.441	4	-1.879
Vārkavas district	-3.378	-2.262	0.118	2.611	4	-2.911
Viļakas district	-0.264	-1.197	-2.479	2.050	2	-1.891
Viļānu district	-0.296	-2.892	-0.429	1.506	4	-2.112
Zilupes district	-1.872	-1.865	3.132	-4.508	3	-5.113

* Districts were divided in 5 clusters: Cluster 1 includes 12 districts (from all 110 districts of Latvia) with the best Smart Governance index value, Cluster 2 -includes 41 districts, Cluster 3 – the middle 17 districts, Cluster 4 - poorly developed in terms of governance 38 districts but Cluster 5 with the worst index value, includes last 2 districts.
Source: EKOSOC-LV data.

However, the AHP method was used in qualitative assessment, analyzing scenarios of smart area formation and growth. The selected 16 evaluation criteria were grouped according to the target groups' interests, incl. 4 criteria used to describe the area of governance. The importance of local governance for smart growth was rated as average (0.17), emphasizing the local officials' capability to attract and use EU funds (0.37), as well as efficient and sustainable use of different resources (0.36).

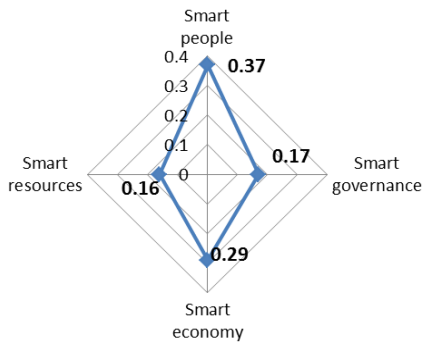

Figure 2 Importance of the Smart Growth Index dimensions from the expert point of view

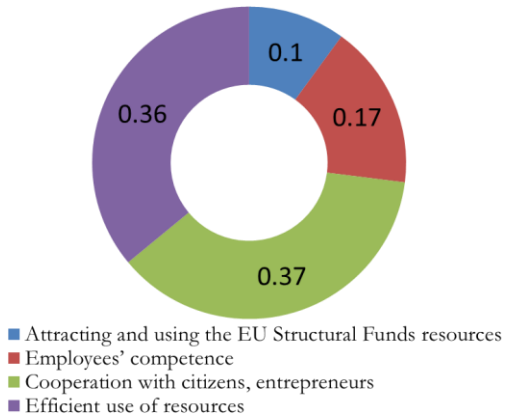

Figure 3 The factors affecting *the Governance dimension* (overal score 0.17) of the Latgale region's smart specialization from the expert viewpoint

Source: EKOSOC-LV data.

The analysis of the information allows concluding that, research results can also be a key element in developing multi-level governance for policies.

Quantitative Smart Growth Assessment revealed that smart growth in Latgale region is characterized by differences at the district level. The complex analysis of the obtained data allows emphasizing that the smart growth of Latgale region is mostly promoted by its rural territories characterized by high performance in the dimensions of *people* and *resources*.

3. Conclusions

Combining quantitatively defined tendencies of smart growth in Latgale region with experts' evaluation (qualitative assessment) it can be stated that among the criteria of local government impact – the local government's ability to cooperate with citizens and employers is the weakest point in development of Latgale region up- to- date.

The performance of the region can be improved if there is mutual communication and cooperation among the most important partners:

- local government, its subordinate institutions;
- educational establishments;
- business;
- civil society;
- other institutions (media, NGO, unions etc.).

Ensuring successful co-operation and activation of the population operation and development of communication channels and developing municipal governance competences in various growth processes (involving sustainable use of local territorial resources, approaches and technologies applied in the use of resources, specifics of governance, institutional capacity, *know-how*, best practice, territorial development potential, and other means and growth-enhancing conditions for promoting well-being) in all levels as well as involving the interested stakeholders are the main opportunities for Latgale growth.

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HOW DO ENTREPRENEURIAL UNIVERSITIES CONTRIBUTE TO REGIONAL DEVELOPMENT AND INNOVATION?

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Abstract
Today, universities all over the world face the challenge of transforming themselves from the traditional focus on research and teaching to becoming more entrepreneurial and innovative institutions. While several university ranking systems such as Quacquarelli Symonds' (QS) or UK's Times Higher Education (THE) rank the world's most prestigious universities annually, ranking entrepreneurial universities is relatively a new concept. We quest for how and to what extent the entrepreneurial universities contribute to the regions of their spatial locations. Do they contribute significantly to the closest proximity of their locations in terms of prosperity, employment growth and innovation? We test the average difference between the county and the state of the entrepreneurial university in terms of the designated measures of regional development and innovation using the most entrepreneurial US universities ranked by Princeton Review in the most recent years, between 2015 and 2018. Our results highlight the significant contribution of entrepreneurial universities to regional innovation and prosperity.

Keywords
Entrepreneurial Universities, Entrepreneurial University Rankings, Innovation, Regional Development, Universities

1. Introduction

Universities are one of the three core components of the triple helix along with industry and government in producing and commercializing knowledge to foster regional development and innovation. [3] brought forward the notion of entrepreneurial universities discussing the need for universities to transform themselves from sole traditional functions of research and teaching to be more entrepreneurial and innovative institutions. While the world's best universities have been ranked annually by popular ranking systems such as Quacquarelli Symonds' (QS) or UK's Times Higher Education (THE) including rankings across broad fields, the ranking of the top universities for entrepreneurship is a new concept.

According to the Princeton Review's top entrepreneurship universities in 2017 for the USA, top 25 entrepreneurial universities are located in 18 out of 50 states where Illinois, Massachusetts, New York, and Texas host more than two universities. These universities offer several entrepreneurship-related courses, many start-ups are launched by graduates of these schools, and they have faculties with high entrepreneurship experience. These features differentiate them from traditional universities according to the Princeton Review's methodology for entrepreneurship. However, the top entrepreneurial universities also differ significantly from the world's best universities according to the prestigious rankings such as QS or THE.

Given the significant differences among leading ranking indexes in measuring the same criterion [10], the difference between top entrepreneurial and all universities is more than that. The difference brings into one's mind several questions regarding the future university models and policies that support entrepreneurship. The reason that most of the top entrepreneurial universities are not placed in the world's best universities could partly be explained by their relatively smaller sizes and specialization in, especially one field (i.e., business schools).

Another challenge that traditional universities face today is the need to evolve themselves into entrepreneurial universities because of the scarcity of funds from governments, increased pressure on competition, and the autonomy of management. To what extent shifting into entrepreneurial universities might help them in competing with their peers and contributing to the region is another issue. Do entrepreneurial universities take a lead in transforming their regions into a cluster of innovation as Stanford University and the University of California Berkeley did in the case of Silicon Valley?

A crucial component of knowledge-based development is the shared assets such as unique local knowledge pools or access to labor markets that are territorial [2] [11]. Using the advantage of their spatial locations entrepreneurial universities could contribute to regional development and innovativeness. We thus explore the extent of the contribution of the entrepreneurial universities to the regional development and innovativeness using the annual entrepreneurial rankings published by Princeton Review and the measures of regional development and innovativeness. We use t-tests to compare the measures at the state and county level where we hypothesize these universities will have the highest impact at the closest locations of their establishments (i.e., county level). Our findings based on statistical tests shed light on the difference in innovation levels between the county and state of the regional location of the most entrepreneurial universities.

2. Entrepreneurial Universities, Regional Development, and Innovation

Starting in the 1980s, universities started to undertake a new mission of entrepreneurship to their existing functions of teaching and research from which the new concept of *entrepreneurial university* emerged [3] [13]. [7] argues that entrepreneurial universities emerged as a response to globalization, national and international competition, and economic pressures on the distribution of government funds for higher education that created an unstable environment for higher education institutions. [9] argue that the mission of new entrepreneurial universities' is to create intellectual capital and new industries.

In general, these universities provide suitable environments for students, academics and staff to investigate or take advantage of entrepreneurship activities. [6] argue that the entrepreneurial university should perform three tasks that are teaching, research and entrepreneurship at the same time. According to [1], entrepreneurship is another component of the production function because entrepreneurship contributes to production and growth by acting as a channel for the dissemination of knowledge, increasing competition and ensuring diversity. Thus, an entrepreneurial university can contribute to the formation of new initiatives that support competition and diversity. As a result, these impacts can produce various externalities in terms of demography, economy,

infrastructure, culture, mobility, education and then productivity, competitive advantages, regional capacities, regional networks, regional identity and regional innovation [5].

[4] characterizes the entrepreneurial university with four distinct features. These features are the close interaction with industry and government, independence, hybridization, and renovation of the reciprocal relations with industry and government. In support to the interaction effect of the components of the triple helix, [8] found evidence of positive synergistic interaction between university and government R&D as well as university and industrial R&D on the firm birth rate in highly active regions in entrepreneurship.

The entrepreneurial outcomes and aspects of entrepreneurial universities put forward the role of such universities in local systems of innovation and the spatial distribution of knowledge transfer and innovation [15]. Entrepreneurship in universities is considered an important driver of innovation [7]. Geographically concentrated systems of universities, firms, suppliers, and customers play a significant role in the competitive success of nations [12]. Norton (2000) emphasizes the clustered linking of venture capital and entrepreneurs in geographical innovation. Furthermore, the basic knowledge produced at universities could be transferred by proper technology transfer mechanisms to the urban level (i.e., city) in the form of technological innovation according to [11].

[14] explore the role of universities in regional development from the perspective of national public policies. In comparing the policy imperatives that encourage different university models in countries UK, Sweden and Austria, [14] find differences of more support for entrepreneurial university models in the UK than in Sweden and Austria.

3. Research Design

This study investigates the impact of entrepreneurial universities on regional innovation and development. Princeton Review ranks the most entrepreneurial universities in the United States every year. Using the most recent rankings (i.e., between 2015-2018), we explore whether the existence of the best entrepreneurial universities in the region reflects higher prosperity, employment and innovation levels in the closest proximity of these universities. Based on the measures of the regional development metrics in the most recent years (either 2015 or 2016), we compare the average levels between the county and the states of the most entrepreneurial universities.

3.1. Data and the Variables

We have access to the characteristics of the U.S. entrepreneurial universities and the development and innovation related metrics of the regions that these universities reside in via secondary data. There are 15 universities that continuously find a place in the annual rankings of the most entrepreneurial universities according to the Princeton Review between 2015 and 2018. These universities with their most recent rankings in 2018 along with information on the location (city, county, and state), the year of establishment and the number of students are provided in Table 1. The list of "Best 25 Entrepreneurial Universities" that is published by Princeton Review has its own criteria to determine those universities. They evaluate the universities according to the following criteria: the academic capabilities, student and faculty relationship, alumni ventures, extra-curriculum activities and competition for business plans. These criteria have also sub-articles such as having classes about entrepreneurship, scholarship, workshops, etc.

Table 1. The Most Entrepreneurial Universities in the United States that are ranked in Princeton Rankings in each year between 2015-2018

2018 Ranking	University	City	State	County	Established in	No of Students
1	Babson College	Babson Park	Massachusetts	Norfolk	1919	3057
2	University of Houston	Houston	Texas	Harris	1927	45364
3	Brigham Young University	Provo	Utah	Utah	1875	33517
4	University of Michigan Ann Arbor	Ann Arbor	Michigan	Washtenaw	1817	44718
5	Bernard Baruch College	New York	New York	New York	1968	18090
6	Northeastern University	Boston	Massachusetts	Suffolk	1898	19940

7	Washington University in St. Louis	St. Louis	Missouri	Saint Louis	1853	15155
8	University of Maryland	College Park	Maryland	Prince George's	1856	40521
9	Baylor University	Waco	Texas	Mclennan	1845	16787
10	Temple University	Philadelphia	Pennsylvania	Philadelphia	1884	39581
11	The University of Dayton	Dayton	Ohio	Montgomery	1850	11721
12	University of Oklahoma	Norman	Oklahoma	Cleveland	1890	31678
13	University of North Carolina	Chapel Hill	North Carolina	Orange	1789	29469
16	Syracuse University	Syracuse	New York	Onondaga	1870	22484
18	Miami University	Oxford	Ohio	Butler	1809	19452

We determine the most entrepreneurial universities' regions and collect the data on appropriate development and innovation measures in these regions. We use *prosperity*, *employment*, and *innovation* metrics to measure regional development and innovation. The reason in choosing these measures is that an entrepreneurial university is expected to bring high-value employment and innovation into the region which will eventually contribute to the prosperity of the region.

The term "region" should be defined carefully in the context of the United States. The United States consists of states as shown in Figure 1. The States are also divided by counties. Figure 2 shows the counties of a sample state (i.e., Texas).

Figure 1. The States in the United States

There are also cities in the states. A city can be inside a county or a big city can consist of different counties. A specific region in the United States is defined as State/City/County. Every university in our study is located in a State, City, and County. For example, the University of Michigan Ann Arbor is located in Michigan/Ann Arbor City/Washtenaw County. The exact location of the most entrepreneurial universities is shown in the map of the USA as shown in Figure 3.

Figure 2. A Sample State (Texas) Divided by Counties

Figure 3. The universities' locations that are shown in Table 1

The main variables that are used in this study are *prosperity*, *employment*, and *innovation*. *Prosperity* is measured by GDP per capita. *Employment* reflects the number of people employed. And, *innovation* is measured as patent counts per 10000 people. In order to measure the development in the regions, we gathered data from *ClusterMapping* which provides data on various economic performance measures including the underlying metrics of this study (i.e., prosperity, employment, and innovation) for every state, city, and county in the United States. The data at *ClusterMapping* are collected from the US Census Bureau, US Bureau of Economic Analysis and the US Bureau of Labor Statistics. Moreover, academics from MIT and Harvard contributed to the preparation of this website according to their own statements.

3.2. Empirical Analysis

We use paired *t*-tests to compare the average prosperity, employment, and innovation between the county and the state that the entrepreneurial university resides in. The results of t-tests showing the averages of the county and state, *t*-statistics, and the associated *p*-values are shown in Table 2. We compare the prosperity and employment in terms of growth rates between 2012 and 2016 whereas actual innovation levels in 2015 (the most recent year available) is employed in the *t*-tests. The four universities among the 15 universities given in Table 1 are excluded from the analyses since these universities are located in a large metropolis where there are many other universities that are likely to affect the regional development and innovation measures. These four universities are the University of Houston in Texas, Baruch College in New York, Temple University in Pennsylvania, and Syracuse University in New York.

Table 2. Paired *t*-test for variables Prosperity, Employment, and Innovation

	Prosperity Growth		Employment Growth		Innovation	
	County	State	County	State	County	State
Average	0.1501	0.1143	0.0969	0.0846	19.3145	10.9064
t-statistic	1.7140		1.0927		1.3775	
p-value (one-tailed)	0.0586		0.1501		0.0992	
df	10		10		10	

The average prosperity growth at the county level is 0.1501 while at the state level it is 0.1143. The associated *t*-statistic is significant at 0.10. For employment growth, while the average employment growth at the county level is greater than the one at state-level, the *t*-statistic is not found to be significant at the chosen level of significance. Lastly, the average innovation (i.e., the patent counts per 10k people) at the county is significantly greater than the average innovation at the state level. Although the

4. Concluding Remarks

Our results, in general, show that the entrepreneurial universities have indeed an impact on the development of their regions. While this effect is significantly positive for prosperity growth and innovation, it is not that significant for the region's employment growth. While the number of patents brings high-value employment to the region, the growth in the number of employees doesn't increase significantly since technologic companies are not correlated with employment. They are rather correlated with prosperity because they make money with few people. The counties become more prosperous and innovative as compared to the states that the entrepreneurial universities located. Thus, the effect is more keen at the closest proximity of the spatial location of the entrepreneurial university. While universities (particularly research universities) in general serve not only to the region but to the whole country [9], the closest regions might benefit most from the entrepreneurial universities as in the case of Massachusetts where the universities such as Northeastern or MIT made this state a hub of science and innovation and their entrepreneurial activities not only concern the region but the whole Unites States. This study could be extended to test cause and effect models with a more extensive set of data using other measures of regional development and innovation. Besides, these models could also be tested with entrepreneurial universities in other countries as contextual variables might affect and interact with the regional performance.

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DOMESTIC GOVERNANCE MECHANISMS FOR COMPETITIVENESS

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Abstract
This paper aims to present the impact of competitiveness indicators on the governance at national levels, linking the general level of economic wellbeing with the evolution of the efficiency of governments, with emphasis on the following neighbour countries: Romania, Bulgaria and Hungary. The period analysed is 2007-2017 and the data was collected from the Global Competitiveness Report (Global Competitiveness Index with reference to the first pillar, i.e. Institutions) and Worldwide Governance Indicators (Voice and Accountability, Political Stability, Rule of Law, Control of corruption, Government effectiveness, Regulatory quality). In order to analyse the relationship between the indicators, correlation and regression analyses were employed. The effect of the governance measures taken by the current government and their impact on the Romanian economy and on the convergence of the country, along with the past experiences in respect to the convergence, affected the economic governance mechanisms. Another aspect assessed by this research is the impact on Romania as a member of the European Union along with its limitations and rules enforced by the Treaty of Maastricht. All of these can ultimately affect and limit certain key decisions with respect to domestic economic governance procedures undertaken at the country level.

Keywords
Global Competitiveness Index, Worldwide Governance Indicators, regression, Bulgaria, Hungary, Romania

1. Introduction

Since the beginning of the 2000s, the number of quantitative empirical studies focusing on the issue related to the convergence between "old" and "new" EU members have been developed. Although there is the framework of the Lisbon Strategy and Stability for Growth Pact for economic governance and competitiveness, some of the new members proved to have powerful convergence through structural reforms [1]. This paper examines to what extent the competitiveness mechanisms, mainly related to the quality of institutions, determines the governance

quality of a country. Commencing from the assumption that the EU defines the framework of economic governance through institutional arrangements and development policy orientation [2], we focus on three new member states from Southeastern Europe. Although appropriate laws and regulations trace the framework for a good society, the confidence in government decisions, the collaborative and active spirit of the citizens and business environment, along with environmental and social responsibility, are the factors that increase the economic competitiveness and improve the quality of the governance.

The paper will continue by presenting the implications of economic governance and country competitiveness on the ability of a developing economy to assume the process of convergence to the level of developed economies. Section 3 presents the data and the methods used in the analysis, reflecting the relationship between competitiveness and governance in Romania and two of its neighbour countries. Section 4 presents the main results, followed by the conclusions of the paper.

2. General aspects of competitiveness

The Global Competitiveness Report (GCR) was created in 2004, and published on a yearly basis by the World Economic Forum. It uses the Global Competitiveness Index (GCI) created to rank countries based on competitiveness [3]. The main concept behind this index is that it assesses the ability of countries to provide economic prosperity to their citizens, which in turn is linked to how efficiently countries use their capital and own resources. Therefore, the index measures a set of policies, institutions and factors with direct impact on the medium to long term economic development, and the ability of such institutions to provide economic prosperity for their citizens.

Since it's inception the GCI is composed out of 12 pillars of competitiveness, and the driving hypothesis behind this is that as a nation develops, the general level of wages tend to increase and thus better labour productivity is needed in order for a country to maintain its competitive edge. Given this, the GCI divides countries based on their productivity driving factors, this resulting into three different stages: factor-driven, efficiency-driven, and innovation-driven, each implying a growing degree of complexity in the operation of the economy.

The countries that find themselves into the factor-driven stage, often compete in the use of natural resources and are characterized by low wages, low to medium productivity and generally unskilled labour. In order for such countries to maintain competitiveness, their efforts are aimed at the following pillars: institutions (pillar 1) both private and public, proper infrastructure (pillar 2) and finally a stable macroeconomic environment (pillar 3). As wages increase, the countries will see a shift from factor-driven productivity to efficiency-driven productivity characterized by the development of more efficient production techniques and increased product quality. By reaching this stage, the pillars supporting competitiveness will be replaced by higher education (pillar 5), efficient goods market (pillar 6), efficient labour markets (pillar 7) and advanced production processes (pillar 11). In the case of Romania and most of its neighbours, the productivity driving factor is a mix between factor-driven and efficiency-driven with a few exceptions that have a meaningful impact on the level of development of these countries.

Although the first country currently ranked by the GCR is the United States, forecasted statistics predict that, under the current conditions and results, China and Japan will eventually surpass the economy of the US. Their convergence period that was driven by inputs such as human capital and factor accumulation of both human and physical capital, sustained in the short to medium term by factor-driven competitiveness with a heavy emphasis on productivity and followed by a shift to an efficiency-driven status that still remains valid. This may be a relevant example to our case study on Romania and its neighbours. Employing the discoveries of Krugman whom, after a careful analysis of the phenomenon of convergence, came to the conclusion that this process will inevitably occur in less developed nations, becoming a natural phenomenon [4].

Romania, a member of the European Union, has certain limitations in terms of economic governance decisions. Some of these limitations arise from the Stability and Growth Pact (SGP) and is further enforced by the Treaty on Stability, Coordination and Governance (TSCG) which limits the maximum annual deficits of any EU member. Given these limitations imposed on member states, one may argue that certain developing countries who seek to reach a convergence process via the implementation of domestic economic governance decisions and investments such as infrastructure (which in fact is the main source of deficits for these countries) may be affected and restrained. An argument for such example can be exemplified by the Romanian wage-led growth policy of the current government, who runs on a deficit mainly based on spending related to salaries from the public sector and pensions, while the government is considered to seek re-election.

3. Data and methodology

The model proposed for observing the correlation between the domestic governance decisions and how Romania maintains its competitiveness among its southern and north-western neighbours is based on the Pearson correlation. The model aims at presenting the relationship between GCR ranking and WGI over a period of 11 years. In terms of the global competitiveness proxies, the data was collected from the website of the World Economic Forum, while the WGI components were collected from the World Bank website. The data refers to annual scores over the period 2007-2017.

The indicators from the global competitiveness index employed in this analysis are the following, with the variable names specified in brackets: Irregular payments and bribes (bribes), Burden of government regulation (burdengovreg), Diversion of public funds (divpubfunds), Judicial independence (judindep), Transparency of government policymaking (transpgovpol), and Wastefulness of government spending (wastegovspend). For the governance indicators, the analysis will include the following components of the World Governance Index, with variable names in brackets: Government effectiveness (ge), Regulatory Quality (rq), Control of corruption (cc), Political stability and absence of violence (pv), Rule of law (rl), and Voice and accountability (va).

The analysis will include two stages. The first one will describe the correlations between governance and competitiveness indicators, identifying the most significant ones, while the second stage of the analysis will refer to regression results obtained through OLS and stepwise regression models. Comparing the results obtained, we will be able to emphasise the governance indicators which are mostly influenced by the competitiveness proxies for the three Southeastern European countries considered.

The regression models considered will have the governance indicators as dependent variables, and the variable from the global competitiveness index as independent variables. Therefore, the general regression model is the following:

$$\text{Gov.ind.}_{it} = \square_i + \square_1 \text{bribes}_{it} + \square_2 \text{burdengovreg}_{it} + \square_3 \text{divpubfunds}_{it} + \square_4 \text{judindep}_{it} + \\ + \square_5 \text{transpgovpol}_{it} + \square_6 \text{wastegovspend}_{it} + \square_{it},$$

where: $\square_i$ (country i = 1...3) represents the unknown intercept of every country, t (t = 2007...2017) is the year analysed, $\square$s are the coefficients for every independent variable, and $\square_{it}$ is the error term.

4. Results

As previously mentioned, Romania is located on the average of the factor-driven and efficiency-driven productivity and will be related to the neighbour countries, Hungary and Bulgaria. In order to highlight the productivity level in these countries and their methods of maintaining their regional competitive advantages, we focus on the first pillar, i.e. the Institutions, in order to present the situation more accurately and objectively.

The Pearson correlation coefficients illustrated in table 1 indicate a high dependency between the world governance indicators, which are all positively correlated. In terms of the bribes indicator, it seems to be directly influenced by the governance indicators, along with the diversion of public funds, as these competitiveness index components seem to be less common when the governance indicators have higher scores, a fact which should be closely observed in the second stage of the analysis in order to see if the significant relationship is confirmed. WGI components also seem to have a direct effect on judicial independence and transparency of government policymaking, reflecting that better governance would be associated with a judiciary system independent from government, and a transparent way of promoting government policies and regulations affecting the business environment. The indirect relationship between WGI indicators and the burden of government regulation and wastefulness of government spending indicate that more administrative requirements from the government, as well as an inefficient use of public revenues, would be associated with higher scores of WGI components.

The linear regression models considering all the six competitiveness indicators as independent variables, retrieved only a few statistically significant results, as observed in table 2. More specifically, the regulatory quality is positively influenced by a reduced level of extra payments or bribes connected with taxes, commerce, public utilities or contracts etc. The judicial independence has a strong direct effect on the following components of governance index: political stability and absence of violence, rule of law, and control of corruption. OLS results also indicated that higher transparency of government policymaking would increase the voice and accountability score, raising citizen' participation in public decisions and government selection.

Table 1 **Correlations between governance and competitiveness indicators.**

	ge	rq	cc	pv	rl	va	bribes	burdengovreg	divpubfunds	judindep	transpgovpol	wastegovspend
ge	1											
rq	0.78	1										
p-values	0											

cc	0.80	0.88	1									
p-values	0	0										
pv	0.80	0.73	0.80	1								
p-values	0	0	0									
rl	0.74	0.84	0.97	0.77	1							
p-values	0	0	0	0								
va	0.64	0.90	0.82	0.64	0.76	1						
p-values	0	0	0	0	0							
bribes	0.47	0.56	0.39	0.47	0.37	0.25	1					
p-values	0.03	0.01	0.08	0.03	0.10	0.27						
burdengovreg	-0.67	-0.65	-0.69	-0.61	-0.72	-0.60	-0.51	1				
p-values	0	0	0	0	0	0	0.02					
divpubfunds	0.10	0.50	0.43	0.18	0.41	0.49	-0.38	0.11	1			
p-values	0.57	0.00	0.01	0.31	0.02	0.00	0.09	0.55				
judindep	0.54	0.74	0.86	0.67	0.89	0.70	0.14	-0.60	0.5087	1		
p-values	0	0	0	0	0	0	0.56	0	0			
transpgovpol	0.52	0.48	0.52	0.30	0.49	0.46	-0.02	-0.39	0.07	0.47	1	
p-values	0	0	0	0.09	0	0	0.93	0.02	0.72	0		
wastegovspend	-0.16	-0.37	-0.42	-0.14	-0.49	-0.38	-0.08	0.51	-0.03	-0.41	-0.13	1
p-values	0.38	0.04	0.01	0.42	0.00	0.03	0.72	0.00	0.85	0.02	0.47	

Finally, the wastefulness of government spending seems to have a predominant indirect effect on governance indicators, but it is statistically significant only for the rule of law. This indicates that a decrease in the level of efficient use of public funds may actually be associated to an increase in the rule of law score, reflecting that citizens and economic agents follow the rules of the society.

Table 2 OLS regression results on governance indicators.

Independent variables	(dependent variable)					
	ge	rq	cc	pv	rl	va
bribes	0.207	0.135**	0.077	0.195	0.053	0.024
	(0.176)	(0.061)	(0.066)	(0.135)	(0.081)	(0.052)
burdengovreg	-0.120	-0.210	-0.104	-0.029	-0.212	-0.168
	(0.379)	(0.131)	(0.142)	(0.292)	(0.174)	(0.112)

divpubfunds	-0.536	0.176	-0.150	-0.341	-0.251	0.078
	(0.489)	(0.169)	(0.184)	(0.377)	(0.225)	(0.145)
judindep	0.124	0.010	0.225***	0.380**	0.318***	0.069
	(0.191)	(0.066)	(0.072)	(0.147)	(0.088)	(0.057)
transpgovpol	0.183	0.110	0.062	-0.095	-0.028	0.192***
	(0.195)	(0.067)	(0.073)	(0.150)	(0.090)	(0.058)
wastegovspend	0.347	-0.094	-0.095	0.290	-0.253*	-0.049
	(0.309)	(0.107)	(0.116)	(0.238)	(0.142)	(0.092)
Constant	-0.750	0.078	-0.360	-1.075	0.999	-0.134
	(2.009)	(0.695)	(0.754)	(1.549)	(0.924)	(0.595)
R-squared	0.466	0.716	0.819	0.622	0.864	0.796

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 presents the results from the final stage of the analysis. Considering the correlations between the governance and competitiveness indicators, and the low level of statistical significance evidenced by the OLS results, we employ the stepwise regression, which will eliminate the inconsistent independent variables, emphasising the competitiveness indicators which are relevant for describing the variance in each of the six governance indicators. The analysis was set to eliminate any independent variable with a statistical significance lower than 80%. Through this final stage of the analysis, any limitations related to the relevance of the regression results are diminished, by emphasising the most relevant competitiveness indicators for governance.

Once again, it is confirmed that the regulatory quality is directly influenced by a low level of extra payments or bribes. In addition, the political stability and absence of violence would be increased based on reduced bribing. For approximately 80% of the cases included in the database analysed, government effectiveness and control of corruption would are be increased with rare cases of bribing and extra-payments for certain services related to public authorities.

The judicial independence maintains its strong positive influence on most of the governance components: political stability and absence of violence, control of corruption, rule of law, voice and accountability, and, for up to 80% of the cases, also on government effectiveness. This proves that citizens are more confident in a system where the judiciary component is independent of the government, and the governance quality may be increased based on judicial independence.

Higher transparency of government policymaking would increase the voice and accountability score, but also the regulatory quality. This proves that citizens may be more active in a society where decisions are transparent, and the public system would perform better based on transparent regulations which promote the development of the private sector.

Table 3 Stepwise regression results on governance indicators.

Independent variables	(dependent variable)					
	ge	rq	cc	pv	rl	va
bribes	0.216	0.128**	0.086	0.265**		
	(0.153)	(0.058)	(0.058)	(0.108)		
burdengovreg		-0.250**			-0.382***	-0.158**
		(0.086)			(0.107)	(0.065)
divpubfunds	-0.613	0.192	-0.286**			

	(0.355)	(0.133)	(0.135)			
Judindep	0.167		0.300***	0.303***	0.244***	0.085*
	(0.112)		(0.043)	(0.085)	(0.066)	(0.041)
transpgovpol		0.121*				0.190***
		(0.063)				(0.052)
wastegovspend					-0.254*	
					(0.135)	
Constant	0.486	-0.077	-0.598	-1.686***	1.151*	-0.026
	(1.315)	(0.589)	(0.500)	(0.476)	(0.571)	(0.334)
R-squared	0.388	0.698	0.787	0.543	0.844	0.786

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Furthermore, for the competitiveness indicators with negative effects on governance indicators, we mention that the highest impact comes from the burden of government regulation. Although the system is not necessarily efficient, results prove that a system of regulations with increased burden on the business environment would actually be associated with higher scores for the rule of law, the regulatory quality, and voice and accountability.

The diversion of public funds is is also affecting the control of corruption and government effectiveness (for up to 80% of the cases analysed). This indicates that although a diversion of public funds due to corruption would occur extremely rarely (i.e. higher scores for divpubfunds variable), it would induce a decrease in the control of corruption and government effectiveness for Romania, Bulgaria and Hungary. With reference to these odd relationships, it is worth mentioning the fact that all these countries have very low levels of control of corruption (the first two present negative values of cc every year of the period analysed), while Romania presents negative values for the government effectiveness indicator.

Finally, the wastefulness of government spending maintains its indirect effect on the rule of law, as a decrease in the level of efficient use of public funds would actually account for more legal responsibility from citizens and economic agents abiding by the rules of society.

5. Conclusions

Romania's membership in the EU and its commitments to the SGP and TSCG had a positive impact on the convergence process, indicating the largest convergence and increase in the economic productivity in the post-adherence period. However, Romania is currently confronting with a migration issue, namely large parts of its active population are working abroad, and as a consequence, the labour market is restrained and the budgetary revenues are decreasing. The latest government decisions related to the constant increase of minimum wage, salaries in the public sector and pensions is deepening the budget deficit. Moreover, good governance is affected by the bribery and corruption cases, and inefficient use of public funds. Although the citizens from developing countries realise that a burdening regulatory system would increase the rule of law, the overall government effectiveness is considered at some of the lowest levels in the world in countries such as Romania and Bulgaria. Given the findings of the statistical model and the evolution of Romania's economy for the period covering 2007-2017, we may argue in favour of the convergence theory, since Romania has seen a recovery after the crisis, coupled with the current governance decisions witnessed over a period of economic growth. The EU membership also helped and with the improvement of competitiveness and some positive modifications of the governance indicators, we conclude that Romania, even if "trapped" between factor-driven and efficiency-driven productivity, is maintaining a competitive status in the regional area, especially when compared to its neighbours, Bulgaria and Hungary. Thus, the competitive and governance indicators may forecast an even more prosperous period after the convergence process has dissipated Even if substantial reductions in the discrepancies between EU countries have been observed, still, some reforms, especially in the quality of our institutions, may be required for new EU countries.

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THE PROMOTION OF UNDERWATER CULTURAL HERITAGE AS A SUSTAINABLE BLUE GROWTH INVESTMENT: INNOVATIVE TECHNOLOGIES AND BOTTOM-UP COOPERATION INITIATIVES IN MEDITERRANEAN AREA

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This paper is about the cultural and economic value of Underwater Cultural Heritage for local communities and supports that raising public awareness is a premise for both the protection and sustainable management of underwater cultural sites. Therefore, the promotion of UCH should appeal to a broad audience and include divers and non-divers, by integrating innovative wet and dry dive technologies and Knowledge Awareness Centers. Cultural diving tourism and virtual dive trails enhance the valorization of Underwater Cultural Heritage, thus offering added economic value attributable directly to local communities. Bottom-up cooperation initiatives of local stakeholders and public authorities is a key parameter of Blue Growth in the Med area. This paper presents a long-term effort in Greece under the framework of national and Euro-Mediterranean projects and its prospects.

Keywords:
Underwater Cultural Heritage, public awareness, innovative technologies sustainable management, blue growth, bottom-up initiatives

Abbreviations
KACs: Knowledge Awareness Centers
UCH: Underwater Cultural Heritage

1. The value of Underwater Cultural Heritage

The Underwater Cultural Heritage (UCH) is a key cultural asset for local communities as it creates a bond with their sociocultural and surrounding natural marine environment. It may include different typologies of sites other than shipwrecks, such as temples, settlements, harbor installations or prehistoric landscapes [1]; in fact, it is estimated that around three million ancient shipwreck sites lie under the world's oceans [2]. Furthermore, the UCH includes not only ancient sunken remains but also modern cultural monuments, like the submerged vessels or aircrafts of the First and Second World War, which are universal memorial sites [3]. With important historic, archaeological and cultural value, UCH has met recently a growing interest internationally as proven by the increasing number of visitors to land-based maritime museums [4] and the regular organization of conferences related to the UCH (e.g. IKUWA).

2. Protection, Accessibility and Public Awareness

Along with the increasing interest on UCH are the threats causing damage to it concerning both human activity and environmental influences. In order to protect UCH, except for the implementation of control mechanisms and legislation, the general public should be educated on its value. According to the Cultural Heritage Diagram, those who understand the value of their cultural heritage are more likely to be actively involved in preserving it; in their active participation, they develop an ongoing interest for its protection [5]. Granted that public access to UCH sites enhances public awareness on its value [3], the UNESCO Convention in 2001 [1] has further highlighted a responsible, non-intrusive access as a premise for UCH protection (*Article 2, §10*) and in situ preservation as a priority (*Article 2, § 5*), thus encouraging public awareness (*Article 20*).

Nowadays, natural or virtual dive trails facilitate a responsible and controlled access to accessible underwater archaeological sites. In situ accessibility practices vary between snorkeling, glass-bottom boat sailing and

recreational or technical diving, while there is also the option of the museum-aquarium settings, such as the Baiheliang and Maritime Silk Road (Nanhai No1) museums in China. Accessibility from a distance appeals to a larger audience including non-divers and calls for the integration of innovative technologies and dry-dive techniques, in particular 3D reconstructions of sites or virtual diving applications. The Vrouw Maria Underwater [6] pilot project and the Historic England Organization [7] have developed such initiatives, through a simple access to a website or a mobile application.

Figure 1. Technologies of Augmented and Virtual Reality in BLUEMED project. Source: UNICAL.

3. Added Economic Value of UCH exploitation

The promotion and management of UCH entangles interrelated issues such as cultural preservation, environmental protection, legislation and operation sustainability. The benefits are accordingly multidimensional, as they can be either educational, sociocultural or in terms of economic growth. Culture is a key contributor to sustainable development [8]; UNESCO proposed that in order to raise public awareness, the management of UCH contribute to the sustainable economic development of a region [9]. In line with this principal are management models and specialized studies, all highlighting the social impact and the economic benefits from the exploitation of UCH, while stressing the need for social participation actions [10]. Cultural dive trails can be such a public attraction and, by extension, a successful investment in the Blue Growth sector; in fact, cultural diving tourism is a popular international leisure practice, famous examples being the wrecks of SS Thistlegorm in Egypt and the SS Yongala in Australia. The Thunder Bay National Marine Sanctuary in the USA has actually had significant contribution to local economy [11].

The promotion of alternate forms of tourism is an emerging trend [12] and cultural diving tourism in particular is a steadily growing market increasing the economic activity in coastal or island areas. Numbers indicate that scuba diving is showing a global growth of 12-14% new divers per annum reaching currently 25 million globally (PADI statistics). It is worth noting that divers visiting submerged sites spend longer time in a region than tourists visiting land museums [13] and have significant indirect expenses such as travelling that normally includes two or three countries and last at least a week. Consequently, the cultural divers' profile of a high spender at off-season weekly destinations fits the parameters of sustainable growth. Therefore, due to its sustainable character and the small investment required, the UCH exploitation can contribute significantly to local economic growth, including profits for businesses and increase of income for local coastal and island communities. Not only will UCH valorization extend the tourist season but also it will have zero negative impact on the touristic profile of a region, since it has a low environmental impact. Most importantly, it is expected to create a competitive advantage for local communities on a Glocal scale, with a high beneficial return directly attributable to local societies.

4. Bottom-up initiatives & Sustainability

There are currently ambitious initiatives addressing to specific or general public on the protection of UCH [14]. The dynamic public response to such efforts is of great significance especially in terms of sustainability, given that the public's participation can support economically the UCH maintenance and keep high standards of protection. Based on sustainability indicators (environmental, cultural, social and economic), the broad public accessibility of UCH due to digitization and the development of cultural diving tourism can be by extension a prosperous source of sustainable economic growth in MED areas, especially for local communities where the only profitable prospect is the tourism investment. Bottom-up initiatives under the framework of national and euro-Mediterranean pilot projects indicate this prospect for Greece.

4.1. "Ano Magniton Nisoi" Model Innovative Development Plan

In 2006, a local initiative for the promotion and valorization of UCH developed in North Sporades region, Greece, with the cooperation of local stakeholders and the support of public authorities. It is an example of good practice regarding sustainable local economic development and environmental upgrading of a region combining unique features; more specifically, rare ecological features (endemic species and endangered mammals such as

the Mediterranean monk seal - *Monachus Monachus*), ancient and modern shipwrecks of great cultural value and the National Marine Park of Alonissos Northern Sporades. The Model Innovative Development Plan *Ano Magniton Nisoi* was awarded upon approval for its innovative and prototype design as an integrated intervention plan. The project was structured on a multi-stakeholder partnership and involved 33 different agents [15], including local associations and professional groups as well as public organizations [16].

The plan proposed the creation for the first time in Greece of pilot accessible underwater archaeological sites combined with diving parks enriched in cases with artificial reefs and sinking of boats, and qualified diving centers supporting its operation. The main idea was to highlight the underwater cultural and natural heritage in situ, promoting public accessibility and thus supporting archaeological survey with the operation of a Research Center for Marine Archeology. Equally innovative was the idea of a world tour exhibition transmitting live images of the ancient shipwreck of Peristera in Alonissos as well as the integration of virtual diving technologies for the non-diving audience.

Due to the viability of its characteristics, the plan was a competitive product on a Glocal level aiming at strengthening tourism infrastructure and diving tourism by creating a new job market in the region. Despite the positive response of the local community and the support of stakeholders and public authorities, the lack of mature framework in the given period did not serve the implementation of the proposal. However, its impact set the grounds for the further negotiation on the issue of the promotion and valorization of UCH and gave the impetus to similar future proposals. Indeed, the follow-up was the "Operational Plan for the Construction of Underwater Museums & Diving Parks in the Sporades Islands & Western Pagasitikos" a flagship project under the National Strategic Reference Network 2007-2013, with an implementation budget of over 5 million euros. It proposes the creation of a network of accessible underwater archaeological sites in an extended area of intervention in the Magnesia region in combination with Organized Diving Areas. Taking into consideration the international practice example and the favorable legal framework, what is crucial about the sustainability of the planning is the promotion of the sites as a total, planning to create a weekly diving tourism destination with a prosperous competitive advantage of a Glocal character. The mature evolution of this original idea is the Euro-Mediterranean project BLUEMED, implementing the design of accessible Underwater Archaeological Sites in three different Mediterranean countries, integrating 4 sites from the Magnesia region in Greece and indicating the prospects for good practice development and growth.

Figure 2. Model Design of Knowledge Awareness Center in Alonissos. Source: UNICAL.

4.2. BLUEMED project

BLUEMED project (https://bluemed.interreg-med.eu/) is a Euro-Mediterranean project developed under the European Interreg 2014-2020 Programme, aiming at developing an integrated multidisciplinary action plan to design, control and coordinate accessible Underwater Archaeological Sites alongside the operation of Knowledge Awareness Centers (KACs). The proposed actions comprise on land and sea services and they are currently being developed in pilot sites in 3 different Mediterranean countries; Italy, Greece and Croatia. More specifically, the sites are the Baia Underwater Archaeological Park and the Capo Rizzuto marine protected area in Italy, the Cavtat Underwater Archaeological Site in Croatia and 4 underwater archaeological sites in Magnesia, Greece: Peristera in Alonissos and Kikinthos, Akra Glaros and Telegraphos wrecks on the west coast of the Pagasitic Gulf.

Modern technologies are applied and documentation studies and rehabilitation work are carried out at the pilot sites, while digital documentation enriches the proposed thematic dive or virtual trails, providing information on both archaeological and the marine ecosystem features. Moreover, an Augmented Diving System improves the diving experience and enhances thematic cultural diving tourism. Through interactive applications available at

Knowledge Awareness Centers (KACs), the users can enjoy a remote diving experience in a virtual reality environment. In addition, KACs comprise an information point and a digital exhibition center of selected finds, to enhance public awareness to locals and tourists on the value of the protection and preservation of underwater cultural and natural heritage. In addition, granted that KACs can be installed at various tourist access points such as airports, museums or international exhibitions they may attract more visitors thus disseminate information about similar initiatives on a global level. At the same time, the online BLUEMED platform (http://meddiveinthepast.eu/web/bluemed) provides archaeological information about each pilot site, as well as diving centers operating in the area nearby and suggestions for organized tours in visiting Mediterranean cultural sites and offers the opportunity for virtual diving in the pilot sites of the project. The platform also serves the creation of a network among Mediterranean regions that comprise cultural tourism destinations and in this context, similar initiatives can be further projected and interact on an international scale.
BLUEMED is actually developing an integrated management model for the sustainable operation of accessible underwater archaeological sites and Knowledge Awareness Centers, with the ticket profits contributing to operation sustainability. Most importantly, the model implementation is supported by already existing state bodies such as the local municipalities, a parameter that is expected to secure the model's viability. The project is co-funded by the European Regional Development Fund and has 14 partners, including the corresponding departments of the Greek and Italian Ministries of Culture, University institutes and local and regional organizations at each intervention area [17]. In order to create a strong and dynamic collaboration network Memoranda of Understanding with different categories of stakeholders have been signed. The predicted numbers of growth for Greece are indicative of the development prospects of the project [18].

5. Conclusions

The aforementioned ongoing effort in Greece demonstrates the effectiveness of local initiatives when implementing collaboration of local stakeholders and support of public authorities. At the same time, it comprises a good practice for blue growth in the Mediterranean area, where people share a common cultural and natural environment and can enjoy the variable cultural and socio-economic benefits of the promotion and valorization of Underwater Cultural Heritage. Responsible public accessibility is a premise and therefore it calls for public awareness and participation of local communities and tourists. Knowledge Awareness Centers and smart specialization via innovative technology contributes to this purpose, while the development of a weekly diving tourism product with at least 5 points of interest is a parameter of operation sustainability. Future planning should also incorporate the unknown wealth of modern underwater cultural heritage in the Greek seas [19] as well as enhance further research, study and mapping of the sites at a regional level. With the support of Regions and Ministries of Culture and Tourism, the Underwater Cultural Heritage should be included in the RIS+ in the next Programmatic Period and take advantage of funding opportunities (ERDF, Interreg or EFSI).

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16. The project involved state authorities such as the Hellenic Ephorate of Underwater Antiquities, the Hellenic Organization for Tourism, the Hellenic Center for Marine Research, the Hellenic Institute of Marine Archaeological Research.

17. The BLUEMED partners and associate partners are: Regional Development Fund -Region of Thessaly, Atlantis Consulting SA, University of Calabria, University of Zagreb-Faculty of Electrical Engineering and Computing, Ministry of Cultural Heritage and Activities and Tourism of Italy, University of Cyprus, University of Patras, Fundation University Enterprise of the Region of Murcia, Dubrovnik Neretva Regional Development Agency DUNEA, Ministry of Culture and Sports of Greece-Ephorate of Underwater Antiquities, Province of Cortone-Marine Protected Area "CAPO RIZUTTO", Municipality of Pylos – Nestor, National Museum of Underwater Archaeology (ARQUA), Soprintendenza Archeologia della Campania. Atlantis Consulting S.A. has contributed to several parts of the project, especially in studying and transferring actions.

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ENTREPRENEURSHIP PROMOTED BY THE PUBLIC SECTOR: GOVERNMENT POLICIES AND ECONOMIC STABILITY

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Abstract
This research aims to investigate the field of entrepreneurship in the context of public sector governance in eight of the largest economies in the world (the G7 countries and Russia). Although suspended from the group since 2014, Russia will be considered part of this study, along with the United Kingdom, United States, France, Germany, Italy, Japan, and Canada. In order to analyse the composition and evolution of entrepreneurship, data from the Global Entrepreneurship Monitor (GEM) was collected, while the GDP, reflecting the economic stability, was based on data from the World Bank. In order to understand the relationships between the public sector governance policies and attitudes towards entrepreneurship in terms of economic development, the 2001-2018 period was considered. The relationships studied were observed through correlation and regression analyses, based on indexes obtained through principal component analysis. Results indicate that there are strong positive correlations between GDP and cultural and social norms promoted in society, total early-stage entrepreneurial activity, physical and services infrastructure, and tax and bureaucracy, while the fear of failure has a negative effect on GDP. In addition, this research emphasises the fact that individuals' entrepreneurial attitude and behaviour may reduce the level of GDP, while the entrepreneurial framework developed by the public sector would have an important role in increasing economic stability.

Keywords
Entrepreneurship, government policies, GDP, principal component analysis, regression analysis, G8 countries

1. Introduction

Since the recent financial crisis, the global economy faces a series of pressures, such as the recession and rapid decline of national economies, massive reduction in consumption, or increased unemployment. Under these conditions, the policymakers confronted with emergency measures intended to help in economic recovery. Accordingly, some of the most competitive economies realised that the business environment needs support to enhance productivity and future prosperity, and focused on fostering entrepreneurship in order to create jobs, provided better access to finance and more opportunities through education. This paper examines to what extent the global entrepreneurship proxies related to the national framework and entrepreneurial attitude and behaviour, determines the GDP and economic stability of a country. Commencing from the assumption that most developed countries are focused on providing the best measures for the development of entrepreneurship, we analysed eight countries, considered the most highly industrialized nations.

The paper will continue by presenting based on the literature review a series of implications of entrepreneurial behaviour and attitudes, and entrepreneurial framework on economic stability. Section 3 presents the data and the methods used in the analysis, reflecting the relationship between Global Entrepreneurship proxies and economy in G8 countries. Section 4 presents the main results, followed by conclusions.

2. Literature review

Some studies describe that innovation is generated by the private sector while the public sector is rather an obstacle to entrepreneurship [1]. In fact, the public sector is one of the key drivers of entrepreneurship, as economic growth and social development depend on efficient public sector organizations which deliver high-quality services. He showed that the link between the public sector and innovation is flexible and complex. This can be explained by the numerous criteria such as the change in services, the organisation, and managerial structure etc. In addition, in order to increase entrepreneurship, permanent communication and exchanges between the public and private sector and non-governmental organisations should exist, as they are all connected in a private-public – social sector.

Innovation employed in improving organisational performance is not necessarily a feature of the public sector in all economies. Moreover, there are significant differences in the organisational and operational aspects of the

private and public institutions [2]. More specifically, public sector programs are developed based on political aspects, which may change drastically from one election period to another. The private sector is usually developed on the free market signals, which may be disruptive but not of political nature. Another difference between the two sectors is related to profit. The private sector is focused on achieving profits or going bankrupt. In terms of the public agencies, their performance is more difficult to be evaluated as there is no aim for profit.

Government policies usually encourage two sides of the business environment: venture capital and entrepreneurial activities. In order to ensure the attractiveness of entrepreneurship, governments must create a favourable environment through several dimensions. First of all, education should be oriented towards entrepreneurial activities, especially at the university level. For this, creative ideas from students should be supported by the governmental framework and academia should provide help in developing such ideas. Regardless of these assumptions, in reality, most entrepreneurs come from the business environment and not from academia, and the entrepreneurial attractiveness is strongly influenced by the tax policy. Another important aspect is related to the investors' depth and knowledge on certain domain and location. Usually, a country or a region that becomes an entrepreneurial hub is attractive for investment. However, the domestic organisations could be rapidly surpassed by international investors undertaking the critical early investments [3].

A reasonable governmental program must consider the needs of the private sector and the market trend. For example, a common problem is related to public venture capital initiatives which are ceased after a period of time due to poor results. This could also be related to the fact that such investment could take years until it becomes profitable, and poor investment analysis is the main reason for this decision failure. Also, some governmental requirements could be detrimental to private sector development. While restricting the location of the business or the level of securities which may be used would affect the entrepreneurial process, receiving subsidies to retain the local citizens employed would represent a supportive measure. The second fact, related to the market trend, is often ignored by the government, which encourages investments in regions with a lack of private interest, leading to a waste of public resources on ineffective programs.

Countries with an effective regulatory framework in terms of entrepreneurship are more competitive and ensure higher productivity through jobs and trade [4]. Accordingly, we expect a direct relationship between the regulatory framework and the development of the business sector, attracting more investments. Based on the components of the framework, less administrative burdens and more simple legislation would support the development of firms, improving the business infrastructure in terms of the general performance of the economy and the access to external funding.

In terms of attitude and behavior regarding entrepreneurship, the cultural aspects should be very important for economic activity, as they have a strong impact on consumption and work, helping in establishing a social network and having a relevant impact on the number of start-ups developed, based on positive attitudes towards funding a business [5]. Although both components of the Global Entrepreneurship Monitor should have a significant impact on entrepreneurship, our analysis will reveal which proxies of entrepreneurial behaviour and which framework proxies are most relevant in the economic development of the G8 countries.

3. Data and methodology

The model proposed for observing the relationship between entrepreneurial behaviour and attitudes, entrepreneurial framework and economic stability is constructed in several stages. In terms of the Global Entrepreneurship Monitor (GEM) proxies, the data was collected from the official website, while the data on GDP was collected from the World Bank website. The data refers to annual scores over the period 2001-2018.

The indicators employed for the global entrepreneurship indexes are the following, with abbreviations specified in brackets: Total early-stage Entrepreneurial Activity (tea), Entrepreneurial intentions (entrepint), Perceived opportunities (percopp), Perceived capabilities (perccap), Fear of failure rate (fearfail), Governmental support and policies (govsuppol), Governmental programs (govprogr), Taxes and bureaucracy (taxbur), Internal market openness (intmkopen), Physical and services infrastructure (physservinfr), and Cultural and social norms (cultsocnorms). The first five indicators previously listed refer to the entrepreneurial behaviour and attitudes of individuals, while the last six represent the national context and how that impacts entrepreneurship. For the economic stability, the analysis will employ the logarithm of the annual GDP at purchasing power parity (PPP), in order to bring the GDP level to one that is similar to the level of the GEM indicators.

The analysis will include three stages. First, correlations between GDP and global entrepreneurship indicators will be determined, emphasising the statistically significant ones. The second stage of the analysis will refer to the construction of two indexes, obtained through principal component analysis. The first ones (PC1, PC2) will be based on the first five GEM indicators, illustrating the individuals' behaviour and attitudes towards entrepreneurship; Another set of indexes (PC3, PC4) will be based on the other six GEM indicators, representing the entrepreneurial framework developed by the government in relationship with the specific economic, social and cultural factors of each country. The final stage will be the regression analysis in order to observe the potential impact the two indexes have on GDP. Through this analysis, we will be able to emphasise the

entrepreneurship indicators related to the society, government and citizens, with the most influence on the economic stability in the G8 countries observed.

The regression analysis based on ordinary least squares models will consider the log GDP as the dependent variable, and the two indexes obtained from the global entrepreneurship monitor database as independent variables. Therefore, the general regression model is the following:

$$GDP_{it} = \square_i + \square_1 PC_{1\,it} + \square_2 PC_{2\,it} + \square_3 PC_{3\,it} + \square_4 PC_{4\,it} + \square_{it},$$

where: $\square_i$ (country i = 1...8) represents the unknown intercept of every country, t (t = 2001...2018) is the year analysed, the two $\square$s are the coefficients for every independent variable (index obtained through the principal component analysis), and $\square_{it}$ is the error term.

4. Results

The Pearson correlation coefficients included in table 1 indicate a statistically significant dependence between the global entrepreneurship indicators. However, there will be no autocorrelation issues in the regression analysis as long as the principal component analysis allows us to build a series of indexes characterised by uncorrelated linear combinations of the variables.

Considering the influential factors for GDP, it seems that most impact (in terms of statistical significance and coefficient values) comes from the Cultural and social norms promoted in society, Total early-stage Entrepreneurial Activity, Physical and services infrastructure and from Tax and bureaucracy. These four variables have a direct impact on GDP, and their high values would support economic stability. The Fear of failure is also an indicator of entrepreneurship with a significant impact on GDP but carrying a negative influence.

Table 1 Correlations between economic stability and global entrepreneurship indicators.

	GDP	entrepint	tea	percopp	perccap	fearfail	govsupppol	govprogr	taxbur	intmkopen	physservinfr	cultsocnorms
GDP	1											
entrepint	-0.0105	1										
tea	0.232***	0.515***	1									
percopp	0.0290	0.587***	0.792***	1								
perccap	0.101	0.514***	0.743***	0.810***	1							
fearfail	-0.193**	-0.0732	-0.377***	-0.264***	-0.542***	1						
govsupppol	0.0666	0.310***	0.156*	0.006	0.107	-0.216***	1					
govprogr	0.0205	0.407***	0.206**	0.240***	0.362***	-0.248***	0.692***	1				
taxbur	0.161*	0.475***	0.421***	0.343***	0.402***	-0.286***	0.649***	0.654***	1			
intmkopen	0.106	0.121	0.486*	0.398*	0.589*	-0.463*	0.339***	0.473	0.438	1		

			**	**	**	**		***	***			
physservinfr	0.200**	0.343***	0.434***	0.184**	0.323***	-0.361***	0.755***	0.691***	0.706***	0.556***	1	
cultsocnorms	0.487***	0.305***	0.786***	0.606***	0.714***	-0.563***	0.115	0.175**	0.405***	0.583***	0.410***	1

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 2 Indexes resulted from the principal component analysis.

Comp.	Eigen value	Cumulative prop.	Variable	Factor loadings		Comp.	Eigen value	Cumulative prop.	Variable	Factor loadings	
				PC1	PC2					PC3	PC4
Comp1	3.194	0.639	tea	0.497	0.032	Comp1	3.62	0.603	govsupppol	0.421	-0.415
Comp2	0.978	0.834	entrepint	0.383	0.526	Comp2	1.153	0.796	govprogr	0.434	-0.285
Comp3	0.456	0.926	percopp	0.507	0.187	Comp3	0.476	0.875	taxbur	0.445	-0.078
Comp4	0.247	0.975	perccap	0.516	-0.151	Comp4	0.333	0.93	intmkopen	0.369	0.463
Comp5	0.125	1	fearfail	-0.287	0.815	Comp5	0.237	0.969	physservinfr	0.476	-0.074
						Comp6	0.181	1	cultsocnorms	0.273	0.722

Based on the Pearson correlation matrix we may conclude that both the individuals' entrepreneurial behaviour and the entrepreneurial framework influence the economic stability of a country. The principal component analysis (PCA) stage allows us to reduce the number of independent variables correlated to each other and create a series of indexes that carry out the main characteristics of the individual behaviour and framework concepts in terms of entrepreneurship. The results of the PCA are presented in table 2.

This analysis provided two indexes from the individual behaviour and attitude variables, as they both explain 83.4% of the total variance. The first two components also have an eigenvalue of approximately 1 or higher, which is another suggestion on retaining two factors from the behavioural side of entrepreneurship. Based on the factor loadings, we can determine the weights and correlations between the variables in every factor built. In the first one, the fear of failure is the only behavioural characteristic with a negative effect on factor PC1, but also with the smallest impact compared to the rest of the variables (the highest impact on the first factor comes from the perceived capabilities and opportunities, and total early-stage entrepreneurial activity). However, for the second factor (PC2), fear of failure has a direct influence and the highest level of impact along with entrepreneurial intentions. Considering that the first factor concentrates the positive aspects of entrepreneurship (individual capabilities, opportunities, and incipient entrepreneurial activity), the second factor reflects the personal attitude towards entrepreneurship, gathering the effect of fear of failure and entrepreneurial intentions.

From the framework point of view, the principal component analysis resulted in two main factors with eigenvalues higher than 1. All the framework variables have a positive impact on the first factor (PC3), but most

influence comes from the physical and services infrastructure, taxes and bureaucracy, governmental programs, and governmental support and policies. The second factor (PC4) is positively influenced by the cultural and social norms and the internal market openness, while the rest of the framework variables carry a negative impact on PC4. However, only governmental support and policies have a high level of weight in the factor (0.415).

Table 3 OLS regression results on economic stability.

	Dependent variable: GDP		
PC1	0.023		-0.055***
	(0.014)		(0.021)
PC2	-0.053**		0.008
	(0.026)		(0.002)
PC3		0.033***	0.071***
		(0.013)	(0.017)
PC4		0.092***	0.141***
		(0.023)	(0.031)
constant	12.485	12.484	12.485
	(0.026)	(0.024)	(0.024)
R-squared	0.0449	0.1393	0.1806
F-test	3.32**	11.41***	7.66***

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3 presents the results from the final stage of the analysis, regression analysis based on ordinary least squares models. We considered three models in order to verify the consistency of the results. The first model regresses the entrepreneurial behaviour and attitude indexes (PC1 and PC2) on GDP. Results indicate a statistically significant relationship between PC2 and GDP, suggesting that the personal attitude towards entrepreneurship have a restricting effect on GDP, as a high level of fear of failure and entrepreneurial intentions will induce a decrease in the level of GDP in G8 countries. The second model employed regresses the indexes resulted from the framework of entrepreneurship and emphasizes the positive influence of both factors (PC3 and PC4) on GDP. More specifically, considering that the two factors gather the direct influences of all the six framework variables, we conclude that the general framework related to entrepreneurship has a positive effect on GDP. The last OLS model performed is based on all the four indexes resulted from the previous stage of the analysis. This time, the factors that are statistically significant are PC1, PC3, and PC4. The first index, related to behaviour and attitudes toward entrepreneurship has a negative influence on GDP, while the factors related to the entrepreneurial framework carry a positive influence on GDP. Overall, the regression results suggest that the subjective side of entrepreneurship, reflected by the individuals' entrepreneurial attitude and behaviour may reduce the level of GDP (as there is a statistically significant indirect relationship between PC1 and GDP, and between PC2 and GDP), while the entrepreneurial framework developed by every country would have an important role in increasing economic stability (based on statistically significant direct relationships between PC1 and GDP, and between PC2 and GDP).

5. Conclusions

The analysis of the G8 countries revealed that both entrepreneurial attitude and behaviour and framework have a significant impact on the economy. The fear of failure carries a negative effect on economic stability, being an obstacle to a business foundation. The perceived capabilities and opportunities also have a negative effect on economic stability, indicating that although there may be good opportunities for starting a business, economic growth is affected. This aspect could be explained by the fact that intentions to start a business and the success of an entrepreneur could be nascent, but this feature is not that common within the citizens of G8 countries. Furthermore, the total early-stage entrepreneurial activity would be associated with a low level of GDP when

considered in the index gathering the positive aspects of entrepreneurship. Therefore, for G8 countries, the economy is more stable when less of its population is either a nascent entrepreneur or owner-manager of a start-up, due to the fact that these economies are strongly industrialised.
Compared to the subjective side of entrepreneurship, relevant through behaviour and attitudes, the framework has more impact on the economy in the countries analysed. Based on the most relevant components of the indexes built, the cultural and social norms are very important for economic growth, followed by infrastructure, taxes and bureaucracy, governmental programs, support and policies. In conclusion, the entrepreneurial framework has the capabilities of generating favourable effects on GDP in the industrialised countries.

According to the main results of our research, entrepreneurship is very important for economic development and stability, being driven by government policies, the level of development of a country, and entrepreneurial behaviour. Although the behavioural component seems to restrain the level of GDP, providing an education oriented towards entrepreneurial activities could have a positive effect on the growth of entrepreneurship in G8 countries, inducing a sustainable growth on GDP.

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EXAMINING ASPECTS OF ACADEMIA - BUSINESS KNOWLEDGE INTENSIVE SYNERGIES IN GREECE. DATA AND TRENDS

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Abstract
In this paper, we present evidence in relation to the synergies established between the academic and business communities. We do so by examining a variety of relevant indicators, namely by making use of a combination of qualitative and quantitative data on research, development and innovation-related activities. More importantly, the data is timely and refers to the most recent years. Findings give out a mixed signal. Whereas some aspects of this synergetic relationship, namely, co-publications, can be improved, other aspects, such as innovative enterprises collaborating with the academia indicate a clear and growing collaboration pattern. Correcting the former and enhancing the latter constitute steps which are especially important in the post-crisis era, where a new growth model and productive restructuring towards a knowledge-intensive pattern is a prerequisite for sustainable growth. On a wider level, this paper contributes to the theorisation on the knowledge intensive synergies between academia and businesses, thus offering empirical level findings towards the ‘’triple helix’’ debate.

Keywords
Academia, Businesses, knowledge-intensive synergies, Greece

1. Introduction

Entering the post-crisis era, Greece is actively seeking a new growth model that places a premium on productive restructuring and initiatives for boosting investment. It is in this context that knowledge-intensive activities have been upgraded in the policy agenda by virtue of their impact on production restructuring and an investment boom that make use of the domestic research- and technology-relevant comparative advantages (e.g. human capital) [1]. Conducive to these factors, has been the introduction of a national strategy for research and innovation, as part of 2014-2020 smart specialisation strategy implementation in Greece, as well as the wider academic and policy debate on Higher Education Institutes (HEIs) and their role in this knowledge-intensive economy. The latter discussion fits well within HEIs' third mission in the context of the existing knowledge triangle approaches. Within this framework, this paper wishes to contextualise the existing level of interaction between Universities and Technological Educational Institutes, on the one hand, and the business sector (BES), on the other. The geographical scope of this is Greece, and it will be conducted by way of presenting various relevant indicators.
Overall, this paper aims to put forward a wide ranging descriptive account, providing an-across-the-board and up-to-date descriptive statistic and numeric indicators of the BES-HEIs interaction. On the wider level, this paper wishes to contribute to the theorisation on the knowledge intensive synergies between academia and businesses.

2. Theoretical background and methodology

Synergies between HEIs and the private sector has been a hot issue, consistently recognised as important in international literature regarding economic development and sustainable growth [2, 3, 4]. According to evidence, enabling knowledge interaction and flows between HEIs with the private sector contributes to economic growth, productive transformation, applied research, technology transfer, etc. Both theoretically and empirically, this aspect of HEIs' operation is directly related to the promotion of the so-called "third" mission of universities [4]. Based on this, multiple theoretical and analytical schemes have been developed, such as the so-called "triple helix" theory, the knowledge triangle approach as well as more nuanced approaches, introducing extra components to the framework of interactions between university, industry and government, such as the civil society, media and the environment.
The underlying thesis has been the need to come forward with a hybridisation of the age-old University, industry and Government activities to generate new institutional and social formats for the production, transfer and application of knowledge. A common underlying feature of all these approaches has been the focus on the interaction of research, education and innovation [6, 7, 8], and the issue of promoting and implementing the idea of modern and "entrepreneurial university". A university, that is, able to re-invent itself and its operation by way of ''stepping on two boats'': that is holding steadfast in its historical mission improving the wider dissemination of knowledge as well as delivering on various societal needs and market realities.
It is in this context that this paper wishes to depict the current state-of-affairs concerning the Greek HEIs-BES nexus. As far as the methodology used in the paper is concerned, this paper makes use of qualitative and quantitative data. In this paper, emphasis is laid on presenting relevant official indicators as gathered by Eurostat and the National Documentation Centre (EKT). Since 2012, the latter has been designated as the national institution responsible for the production of the official national statistical data on RDI. Of special value is the fact that since 2012, a comprehensive, regular time series of these statistical indicators has been made available. In addition, a range of other relevant indicators that refer to the formal/informal HEIs – businesses collaboration in knowledge-intensive activities that are also collected by EKT by virtue of its role in the national innovation system, are also presented.
In more detail, variables that are made use of herein include:

i) R&D statistics on synergies for performing and funding R&D activities,
ii) entrepreneurial metrics on innovation based on results of the Community Innovation Surveys (CIS) - the latter explicitly focus on examining potential BES-HES co-operation for producing innovation,
iii) metrics on recent public initiatives for supporting BES-HES cooperation for applying R&D projects,
iv) a bibliometric analysis of co-authored publications, and
v) qualitative data drawn from a recent field survey on HEIs' interactions as part of an OECD initiative on the knowledge triangle.

In the cases where cross-country indicators on the above mentioned-empirical data are available, this paper makes use of such indicators to make comparisons on an international (namely, European) scale.
The objective of the paper is to provide up-to-date data on the HEIs-businesses collaboration, thus shedding light on the existing situation of this interactive aspect of knowledge intensive activities in Greece.
Provision of such indications can be ''tied'' to specific and actual comparative advantages and weaknesses of the national innovation system, as well as provide a sign-post of its potential for the future, post-crisis era in Greece.

3. Factual analysis

This section aims to present the relevant data on the various aspects of the HEIs-businesses collaboration in various areas of RDI-relevant activities.

In the following table (Table 1), we present evidence concerning the range of R&D collaboration between HEIs and businesses in R&D projects. When referring to R&D statistics on synergies for performing and funding R&D activities, data shows that the share of R&D that is performed by HEIs and is funded by the business sector is of highly relevant statistical information since it provides a percentile account of this kind of collaboration. More to the point, we estimate this particular indicator, both as a percentage of higher education expenditure on R&D (HERD) and gross expenditure on R&D (GERD), in order to compare the Greek performance to the average of EU. In this case, for the 2011-2016 period, Greek HERD (as a share of gross expenditure on R&D (GERD)) funded by the business sector reaches the approx. 3% and actually almost double the EU28 average (e.g. GR: 2,9% vs EU: 1,5% in 2015).

This finding can be also viewed in relation to the Greek HEIs expenditure on R&D funded by the business sector as a share of total HERD. According to the data, the difference between the Greek performance and the EU average is not significant (e.g. GR: 7,6% vs EU: 6,4% in 2015), although the former still exceeds the latter (Table 1). This trend may be attributed to the fact that Greek HEIs have been diachronically the principal R&D performer in Greece. As a result, HERD stood –at least until 2017– as a substantial share of GERD, especially compared to international trends.

Table 1 R&D Performed by Higher Education Sector and Funded by Business Enterprise Sector (as % of HERD and GERD)

	2011		**2012**		**2013**		**2014**		**2015**		**2016**	
	as % of HERD	*as % of GERD*	*as % of HERD*	*as % of GERD*	*as % of HERD*	*as % of GERD*	*as % of HERD*	*as % of GERD*	*as % of HERD*	*as % of GERD*	*as % of HERD*	*as % of GERD*
EU28	6,5	1,5	6,4	1,5	6,4	1,5	6,4	1,5	6,4	1,5	6,5	1,5
Greece	9,0	3,6	7,9	3,1	5,5	2,0	6,0	2,2	7,6	2,9	7,3	2,3

source: EKT, Eurostat, authors' calculation

Another indicator that provides evidence on the networking potential between HEIs and businesses can be derived from the CIS survey. In more detail, this indicator refers to innovative enterprises that establish collaborations for carrying out product and/or process innovation activities. The following figure refers to evidence from the latest CIS round (2014-2016), illustrating a cross European country comparison, according to which Greek enterprises indicate a higher than the EU average degree of engagement in cooperation with HEIs. Indeed, Greek firms stand in 5th place among EU countries.

Seen across time, significant fluctuation can be observed. This fluctuation is observed when comparing the CIS 2014-2016 results to those of past series of the survey (e.g. in the 2012-2014 CIS round, the country is ranked in 20th place and in 6th place in the 2010-2012 survey).

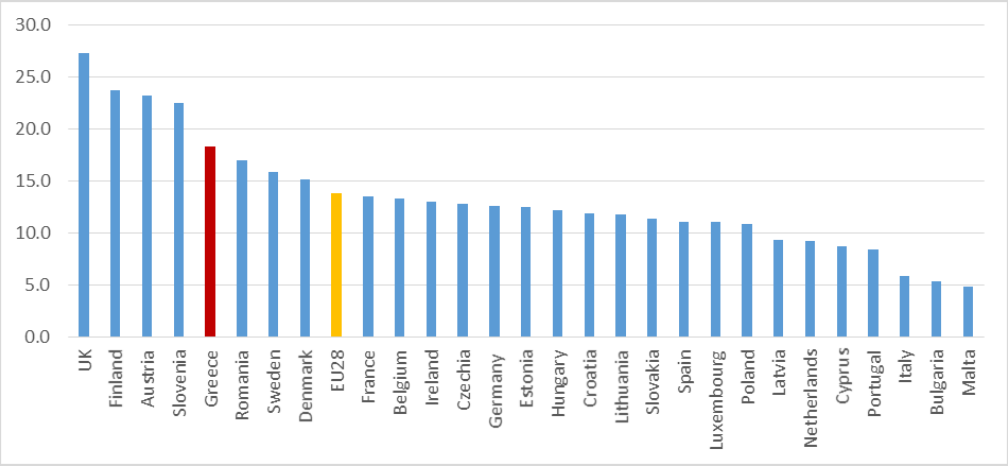

Figure 1 Share of enterprises engaged in product and/or process innovative activites in co-operation with HEIs, 2014-2016

source: EKT, Eurostat, own calculation

A third data source on the level of collaboration between HEIs and the private sector can be found by way of making use of R&D related public tenders and calls. Sachini et al. [16] recently analysed the joint publicly funded R&D projects of the Greek General Secretariat for Research and Technology. They conclude that the level of such collaboration is strongly related to the binding terms and conditions of the tenders and calls at hand. More specifically, only for those programmes, projects, etc. wherein collaboration between HEIs and the private sector was deemed as a formal requirement according to the rules for participation (i.e. obligatory), can a substantial collaboration pattern be observed. In all other cases of programmes, projects, etc. where the decision to collaborate or not is left up to the will of the participants (i.e. optional), the rate of collaboration is decidedly lower. Thus, it appears that these programmes insufficiently nurture the creation of innovation-targeted linkages (Table 2). This implies sub-optimal exploitation of research and knowledge production, as well as inadequate technology diffusion throughout the economic and social fabric.

Table 2 The range of Business-HEIs R&D collaboration in GSRT programmes, 2007-2013

No.	Programme no.	Sectoral focus	Type of collaboration between HEIs/PRIs and business collaboration	% of GSRT's programmes budget (*)
1.	22+	HEIs/PRIs	Non existent	25%
2.	10	HEIs/PRIs and businesses	Optionally	10%
3.	7	Businesses	Non existent	11%
4.	2	HEIs/PRIs and businesses	Obligatory	30%

(*) For the remaining % of GSRT R&D actions, no detailed data was available.

source: [16]

An additional data source is data collected through other public interventions such as ''Activities concerning Tertiary Education'' that aim towards upgrading the research potential of HEIs, such as support of post-doctoral research, PhD candidates and research teams consisting of young scientists, funded by the 2014-2020 National Strategic Reference Framework. While these interventions mainly aim towards replenishing the declining academic/teaching personnel by way of funding teaching and R&D-relevant activities, a series of enterprise-friendly indicators can be derived. Specifically, when asked whether young scientists would collaborate in the future with firms in order to further exploit their current research idea/project, approx. 70%-80% of the beneficiaries responded that they would be willing to do so (Figure 2).

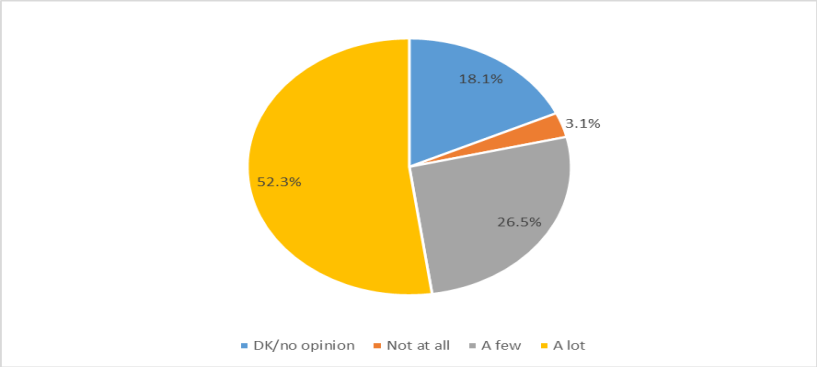

Figure 2: Potential R&D collaboration between young scientists and enterprises (as % of beneficiaries' responses), source: [17-19]
source: [17, 18, 19, elaborated data]

Bibliometric analysis is another data source upon which BES-HEIs interaction can be observed. Bibliometrics is the process of extracting measurable data through statistical analysis of published research studies and how the knowledge within a publication is used. Specific bibliometric indicators (university–industry co-publications (UICs)) can be used as a proxy for examining the level of interaction between the academic community with the business world.
The following figure (Figure 3) presents the relevant European Innovation Scoreboard data for the period 2011-2018. Greece hovers around 31,5 for the entire period, reaching an all-time high value of 36,6 in 2016, whereas the EU average is 78,8, with an all-time high value of 83,3 in 2017. This indicates a case of significant lagging at the level of public-private co-publications in international journals in Greece in comparison with the majority of EU countries (Figure 3).

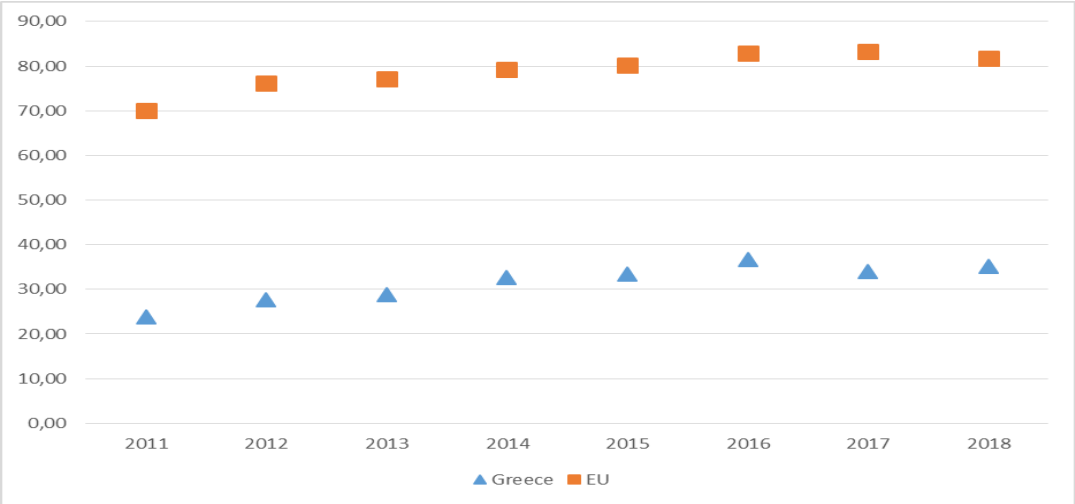

Figure 3: Greek and EU average, public-private co-publications (per million of population), 2011-2018
source: [20]

Furthermore, another data source refers to qualitative data, drawn from a recent field survey on HEIs' interactions within economy, as part of a 2016 OECD initiative on the knowledge triangle in its member states. According to the evidence, one of the unforeseen effects of the economic crisis seems to be directly related to an enhanced intention of both HEIs and enterprises to participate in RTI-related synergies. This came as a result of the significant decrease of public funding for HEIs, which made academics realise the need to establish links with the private sector. Similarly, the private sector responded that realised the need to collaborate with HEIs so as to tap the potential of a growth-related, knowledge-intensive university pool [14].

4. Discussion

The issue of BES-HEIs interaction as a means of contributing to the wider socio-economic development has been hovering high on the policy agenda [2, 3]; in addition to relevant declarations and the introduction of incentives, a continuous need for introducing and applying more and better indicators revealing broader dimensions of this complex and critical phenomenon have been put forward. Given that synergies between HEIs

and the private sector are multidimensional activities for both actors of national innovation systems, an increased appetite for combined, quantitative with qualitative data analysis, is in demand. This has been the scope of this paper, as it relies both on official data, produced by EKT, the Greek statistical agent on RDI metrics, coupled with other various numerical and qualitative indicators.

The evidence put forward indicates that the quality and leverage of the academia-enterprises nexus is rather mixed regarding research and innovation-related activities. In more detail, up to 2016, the business sector's contribution to R&D funding and performance had been rather low, indicating on the one hand specialisation in productive sectors of low to medium technology intensity, and on the other, inadequate technology diffusion throughout the economic and social fabric.

However, the broadly accepted view about the problematic relationship between academic community and the business sector seems not to be fully validated from recent data. For example, data on R&D synergies reveal a rather satisfactory level of cross-sectoral collaboration when examining R&D performed by HEIs, which is funded by enterprises. This is the case, despite the fact that when referring to the high level of Greek performance in the R&D conducted by HEIs and funded by the business sector (as % of GERD), one should bear in mind that HEIs have persistently been the main R&D performer. This remains at odds with EU and international cases, even though during the last years firms have been significantly boosting their R&D spending. In addition, Greek and average EU28 performance in terms of higher education expenditure on R&D (HERD) is similar.

The same complex situation is also presented when examining the collaborative activities of innovative enterprises. On the one hand, synergies with HEIs do exist, but, as reported by the enterprises themselves, they do not stand as the main source of inspiration for carrying out innovative activities.

At the same time, synergies on joint publicly funded R&D projects are rather few. This is related to the fact that NSRF funding directed to R&D activities has followed by and large the pattern of previous CSFs. That is, HEIs actively seek to co-operate with businesses (and vice versa) only in those R&D projects where such synergetic behaviour has been an obligatory precondition to participate, indicating the importance of legislative arrangements as a means to incentivise such collaborations. Furthermore, a number of issues arise in this context, as funding for R&D, in general, and funding that links HEIs and businesses, in particular, is limited to approximately 1% of total NSRF funding [16].

In terms of public financial intervention schemes targeting young researchers, results indicating that the approach of the latter towards engaging with enterprises is more optimistic. More than half of them express their strong willingness to engage with the private sector to further their academic research and enhance the potential uptake of their research by firms [17-19]. This, however, should be viewed for what it is – that is, a statement on future intentions as coming from the researchers and not actualised synergies.

In relation to public-private co-publications, Greek performance is significantly lower than the EU average. Importantly, this indicator remains diachronically low and stands as one of those stumbling blocks that need to be addressed in a comprehensive manner [20].

Overall, and in line with some aspects of the triple helix approach that lay emphasis on interaction between HEIs and businesses [22, 23], the domestic business sector has been making inroads towards increasing their contribution to research production. Similarly, HEIs approach towards the private sector has been, by and large, similarly accommodating. Both observations indicate a potential path towards a growing and more effective exploitation of knowledge production.

In the same vein, according to the CIS data, innovative companies have been forging academic ties and collaborations for the purposes of carrying out product and/or process innovation activities. Obviously, this trend should be further made use of in a positive manner. A manner that would enable a collaborative spirit among academia and enterprises.

5. Conclusions

This paper presented various indications detailing the existing level of interaction in Greece between Universities and Technological Educational Institutes, on the one hand, and the business sector, on the other. The aim has been to provide an-across-the-board descriptive statistical analysis of the BES-HEIs interaction. In this spirit, this paper contributes to theorising knowledge intensive synergies between academia and businesses, shedding some light on the growing need to address the degree to which HEIs and the business sector interact in terms of knowledge- and technology-co-production. Building upon up-to-date data, the highlighted channels of collaboration provided new insights on the level of sophistication indicated by these particular synergies and the potential for the future.

The approach in this paper built upon factual analysis and indicated that the existent level of this kind of synergies brings to the fore a more complex picture compared to the broadly accepted and the broadly accepted view that there is major lack of HEIs-business collaboration in the Greek research and innovation system.

Specifically, data and trends when examining aspects of knowledge intensive synergies between academia and businesses in Greece, send out a mixed signal. While some aspects of this relationship (namely, co-publications) should be assessed carefully, other aspects (innovative enterprises collaborating with HEIs) indicate a clear and

growing collaboration pattern. Correcting the former and enhancing the latter constitute steps which are especially important in the post-crisis era, where a new growth model and productive restructuring towards a knowledge-intensive pattern is a prerequisite for sustainable growth.

On the other hand, the issue of collaboration arrangements and its sustainability beyond the scope of specific programmes or projects, as in the case of GSRT calls in the 2007-2013 programming period, is a point worth further considering [16]. In addition, building robust linkages and synergies between HEIs and BES is a crucial parameter, for which trust and consistency are important. On this, bringing to the fore successful collaboration schemes and analyzing the manner in which this was made possible so as to replicate, is a case for future research. While HEIs have an important role to play in respect to economic and social growth, full potential can only be accomplished with enacting collaborative arrangements with the private sector. EKT, as the national statistical agency on R&D, aims to shed more light on this particular subject producing relevant indicators that would enable more comprehensive analysis.

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