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ORIGINAL PAPER

DISCREPANCIES BETWEEN CLUSTER SERVICES AND SMES' NEEDS CONSTRAINING THE CREATION OF A CULTURE OF INNOVATION AMIDST INDUSTRY 4.0

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ABSTRACT. **Background:** SMEs performance and their innovativeness are associated to their participation in innovation networks. Thus, SMEs tend to join clusters aiming to accelerate their process of innovation, catch up with the dynamics of the industry and increase their probability to access external knowledge and resources. Consequently, promoting a collaborative atmosphere by boosting the synergies between cluster managers and SMEs will foment a culture of innovation. Moreover, the inclusion of new technologies, and especially the advent of industry 4.0, is facilitating collaboration, while at the same time accelerating the development of innovation outcomes and setting new challenges for SMEs. This contribution identifies discrepancies between offer (clusters) and demand (SMEs), hindering the creation of a culture of innovation and highlights critical points, where both SMEs and Clusters, may gain from a proper interaction.
Methods: 120 empirical studies analyzing innovation determinants have been evaluated. Based on these determinants and stressing the importance of SMEs participating in collaborative-networked innovation actions, a concept for supporting the creation of a culture of innovation is proposed. This concept is enhanced by exploring potential benefits of industry 4.0 technologies supporting the acquisition, assimilation and transformation of knowledge into innovation. Additionally, in order to gain an insight about the interrelation between clusters and SMEs towards the creation of an innovation culture, an empirical study has been conducted.
Results: The descriptive analysis shows that communication problems and discrepancies between cluster organizations and SMEs are evident. Moreover, the understanding of SMEs on the requirements for building an innovation culture is rather low. Although cluster organizations tend to generate services supporting their members' innovation processes, a gap between offer and demand is observable among all phases defined in the concept.
Conclusions: we suggest that cluster managers could play a more preponderant role as orchestrators of innovation by adjusting their services to the requirements of each innovation process phase. Moreover, this work highlights inconsistencies between offer (clusters) and demand (SMEs) constraining the creation of a culture of innovation, particularly stressing communication problems. Hence, the integration of innovative communication channels, having the potential to increase the effectiveness of communication strategies between cluster managers and SMEs, are key for facilitating a culture of innovation in organizations, especially in SMEs. In this case, we suggest exploring different elements around the industry 4.0 in order to define the characteristics of such communication channels, particularly those supporting the acquisition, assimilation and transformation of internal and external knowledge into innovation.

Key words: determinants of innovation, culture of innovation, innovation networks, cluster management, Small and Medium Enterprises (SMEs).

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INTRODUCTION

Most organizations are intrinsically motivated to undergo innovation, since it gives them the possibility to augment their performance and retain their competitive advantage [Rosenbusch et al. 2011]. Nonetheless, although SMEs tend to take part more frequently on radical innovation than their counterparts [Dougherty, Hardy 1996], different studies have shown that generally their participation in innovation actions is hampered by their lack of financial resources, limited opportunities to recruit skilled workers, deficient monitoring structures, scarce access to new technology, lack of external partners opportunities and small portfolios for their innovation [Rammer et al. 2009]. Besides lacking on resources to perform the activities related to innovation, SMEs rarely line up their internal structures to reduce risks and avoid failure in the medium and long term. Moreover, most SMEs do not follow a systematic innovation process and struggle structuring their actions [O'Regan et al. 2006].

Hence, especially for SMEs, cooperation strategies are often the only possibility to overcome their deficiencies towards innovation and become part of global value chains [Zeng et al. 2010]. Literature in this regard shows a positive correlation between SMEs' innovation performance, innovation efficiency and their innovativeness to be associated to SMEs participation in innovation networks [Bougrain, Haudeville 2002, Gronum et al. 2012]. Thus, aiming to accelerate their process of innovation, catch up with the dynamics of the industry and increase their probability to access external knowledge and resources, organizations tend to make formal alliances with peers and clusters [Donnet et al. 2010, Rosenbusch et al. 2011].

Moreover, collaborative innovation networks are gaining relevance since innovation is closely linked to the management of internal and external knowledge [Cassiman, Veugelers 2006, Tsai 2001, Purcell, Mcgrath 2013]. Hence, procuring to improve communication channels between different agents holding valuable knowledge could ignite and at the same time accelerate the innovation process. In this regard, the 'industry 4.0' strategy is setting new challenges for organizations, while at the same time facilitating and supporting the innovation process and strengthening a culture of innovation inside organizations [Baum 2013, Kreutzer, Land 2016]. Particularly, the literature discusses that technologies and methods associated with the strategy industry 4.0 e.g. Cyber-Physical Systems (CPS), Big Data Analysis, Machine learning; could help to capitalize internal and external knowledge not only to reinforce operational processes, but also to ignite and fortify the process of innovation [Baum 2013, Kieninger et al. 2015, Henning 2013].

Consequently, this contribution will be focused on identifying and analyzing the activities fashioning this 'formal interaction' between cluster managers and SMEs that could ignite a Culture of Innovation (CI). Moreover, we explore technologies and methodologies associated with the 'industry 4.0' strategy that could support not only the interaction between SMEs and cluster managers, but also that could facilitate the participation of SMEs in collaborative-networked actions. Hence, this paper identifies: (1) the discrepancies, between offer (clusters) and demand (SMEs), hindering the creation of a culture of innovation, (2) industry 4.0 technologies supporting the interaction between agents, particularly those interactions involving the generation, assimilation and transformation of knowledge, and (3) critical points, where both SMEs and clusters, may gain from a proper interaction.

CHARACTERISTICS OF A CULTURE OF INNOVATION

Defining the culture of innovation

The culture of innovation refers to the definition and implementation of strategies helping organizations to continuously develop capabilities and improve their structures towards innovation [Ahmed 1998]. It sees the innovation process as a holistic process,

enrooted in all structures of the organization. As a consequence, organizations having a culture of innovation are oriented to relentlessly acquire, assimilate, transform and exploit knowledge. Hence, those actions towards building the culture of innovation have to be carefully enforced, since they may either facilitate or constrain the learning abilities of the organization and thus its innovation capacity [Brettel et al. 2015]. Thus, organizations willing to excel at innovation, and moreover, at creating an innovation culture, should start by setting and adjusting their structures and goals towards developing capabilities that allow them to continuously undergo innovation actions [Ahmed 1998, Rosenbusch et al. 2011].

The innovation process as the main body towards the operationalization of the culture of innovation

Organizations following a defined innovation process tend to accelerate the generation of new products and become able to evaluate and select those ideas in the early stages with few probabilities of success [Barczak et al. 2009, Manion and Cherion 2009]. However, although innovation models portrayed in the literature are providing guidelines to operationalize the process of innovation, they should be adjusted and customized each time the organization is confronted with an innovation action [Gassmann et al. 2010]. Moreover, some studies have shown that combining or adding different strategies to the innovation process increases their rate of innovation success [Barczak et al. 2009, Manion and Cherion 2009]. The formalization of customized strategies is even more relevant for organizations taking part on collaborative innovation, since the complexity of the innovation increases due to the participation of different organizations [Rammer et al. 2009, Meroño-Cerdan, López-Nicolas 2013]. Hence, organizations are obliged to adjust their structures towards operationalizing their innovation actions, but also they are compelled to define additional strategies to cope with the strain of knowledge and better leverage the capabilities brought by their partners.

Identification of the problem and idea generation	Identification of internal or external problems or opportunities about which the organization wants to generate ideas to solve the problem or capture the opportunity
Concept generation and implementation strategies	Development of a customized concept for solving the identified problem and giving structure to the selected idea(s)
Research and development to build up the defined concept	Experimentation and pilotage of the noteworthy idea(s) to test how well they work on practice
Introduction to the context	Definition of the commercialization strategy for supporting the introduction and dissemination of the innovation(s)

Fig. 1. Phases of the innovation process and their main goals

The literature regarding innovation has shown that this operationalization can be achieved through the definition and implementation of an innovation process [Cooper 1990; Barczak et al. 2009]. In order to acknowledge the most important phases organizations undergo towards the operationalization of their innovation actions, 28 different innovation models were examined. The vast majority of models consider as main constructs: (1) Identification of the problem and idea generation; (2) Concept generation; (3) Research and development to build up the defined concept; and (4) Introduction to the

context [Cooper 1990, Berkhout et al. 2006]. These phases are taken as the main body to operationalize the process of innovation and ignite the generation of a culture of innovation. Additionally, Fig. 1 summarizes the main goals for each phase of the process suggested by authors.

DETERMINANTS INFLUENCING THE CREATION OF A CULTURE OF INNOVATION IN SMALL AND MEDIUM ENTERPRISES

Characteristics of the literature analysis identifying determinants of innovation in SMEs

Aiming to acknowledge the distinctive capabilities required from organizations wanting to improve their chances while undertaking innovation actions, a systematic literature review has been conducted. This analysis should permit the identification of the determinants that have the potential to foster or constrain innovation.

The combination between the words "motives or determinants or effects or drivers" and "innovation and Small and Medium Enterprises or SMEs" in the categories abstract, keywords or title were used to search for scientific articles on Web of Science and Science Direct databases. The results yielded 411 articles, of which 296 were from Web of Science and 115 from ScienceDirect correspondently. After a round of cleansing up the data due to irrelevance of title/abstract, publications not addressing empirical information, publications in languages other than English and screening of duplicates, 120 publications remained for qualitative assessment.

The qualitative assessment of the papers followed four steps: (1) the dependent and independent variables from the remaining publications were identified; (2) the independent variables were characterized to recognize their positive and negative impact over the dependent variable; (3) the dependent variables were categorized based on the measurement goal sought by the authors and finally (4) a membership categorization analysis was carried out to look after those determinants (independent variables) positively and negatively affecting the absorptive capacity and innovation performance of organizations, particularly SMEs (dependent variable) [Fitzgerald 2015].

Current drivers and constraints for SMEs developing innovation traits

As previously discussed, organizations are aware of the benefits of gaining innovation capabilities and turning their structures to be more innovation-oriented. Nonetheless, organizations tend to be hesitant to generate innovation traits mainly because of the costs and risks associated with them [Schmiele 2012, Madrid-Guijarro et al. 2009]. This behavior is more prolonged in SMEs, where their workforce is ingrained in the daily operative process, leaving slightly room to foster creativity and adopt business practices towards innovation [Meroño-Cerdan, López-Nicolas 2013, Nieves et al. 2016].

The membership categorization analysis carried out as part of the literature analysis allowed classifying the determinants into five categories favoring the process for creating the culture of innovation: (1) preconditions or firm characteristics and behavior towards innovation; (2) characteristics required for recognizing the problem and generating possible solutions; (3) concept generation and implementation strategies, learning and absorptive capacity; (4) Research and development to build up the defined concept; and (5) introduction to the context. Hence, Table 1 portrays the determinants of innovation that can affect positively or negatively the innovation process and consequently, the creation of a culture of innovation in SMEs. It is important to remark, that some of these determinants can be applicable in different phases of the process, however in an attempt to reduce redundancies most of the determinants were made explicit only in one phase.

Table 1. Determinants influencing positively and negatively the creation of a culture of innovation

	Phase 1: Setting/Adjusting the conditions required to support innovation (preconditions)
+	Invest in generating a culture towards innovation
+	Risk-taking and strategic orientation towards innovation
+	Acquisition of external knowledge and technology
+	Market orientation and customer/suppliers involvement
+	Identification of and access to financial support
+	Higher educated workforce and support further development of their skills (technical and management)
–	Innovation unfamiliarity, lack of innovation experience and negative attitude or perception towards innovation
–	Being passive or assuming a reactive rather than proactive position towards innovation
–	Limited initial technology resource and lack of specialized knowledge and technology
–	Poor involvement of the management, dependence of the board and poor managers skill
–	Hierarchical culture, lack of organizational flexibility and high process inertia
	Phase 2: Identification of the problem and idea generation
+	Proximity advantage related to interaction with: suppliers, research institutions and consumers
+	Involvement of consultants and definition of activities for controlling and forecasting firms' results, new markets and business opportunities
+	Use of knowledge management strategies (communication flow) and promote resource integration
+	Foster idea management capabilities, monitoring competitors and include supplier and customer as a source of innovative ideas
+	Training programs on cooperation with external stakeholders and participation in collaborative projects
+	Participation in trade fairs, conferences and discussions with customers and other industry actors
–	Lack of an innovation strategy and proper information on industrial development and on market development
–	Neglect the work with universities and other research centers to build knowledge resources
	Phase 3: Concept generation and implementation strategies
+	Training of personnel in innovation projects
+	Involvement of frontline employees
+	Formal internal and external research and definition of an structured innovation process
+	Frequency of research and development (innovation intensity and technological capability) and high interaction with research and development institutions and technology consultants
+	Strong and clearly defined customer problem or need and recognition of consumer preferences
+	Inter-firm cooperation and use of external networks
–	Reluctance to work closely with consumers to develop new concepts or to learn from other firms
–	Insufficient knowledge, technology and resources
–	Poor external partnership and difficulty in finding cooperation partners for innovation
	Phase 4: Research and development to build up the defined concept
+	Use of patents, designs or other internal or external intellectual property (IP) rights (Open Innovation)
+	Access to research/technology and commercial laboratories through collaboration
+	Continuous actualization of equipment or technology
+	Further development of technological skills
+	Technical feasibility and consistency with the organization's product base
+	Gain synergy effects between innovation processes
–	Lack of information on technology and imperfect evaluation criteria for identifying external knowledge
–	Technologies not adequate or not available
–	Complexity of the production process
	Phase 5: Introduction to the context
+	Perform market research and continuously monitor competitors and customer needs
+	Collaborate with technology market/intermediaries and venture capital organizations
+	Develop market-related exploitative capabilities
+	Formal business planning and definition of market introduction and general marketing strategies
–	Rarely compare products and processes with those of its competitors
–	Deficient marketing skills, inadequate marketing strategies, poor advertising and lack of marketing channels

Challenges and opportunities of industry 4.0 for the creation of a culture of innovation

From a knowledge management perspective, the cohesion and degree of interaction between tacit and explicit knowledge inside a system acts as the catalyst and enabler of innovation [Argote, Ingram 2000, Johannessen, Olsen 2009]. Thus, scholars recognize that 'knowledge' is more than the information that organizations have and share; it goes further to include tacit elements inherent to each individual. However, the transformation of information into new knowledge implies the process of assimilation, socialization, combination and application of tacit and explicit knowledge [Nonaka, Takeuchi 1995:9]. Therefore, as observable in Table 1, the majority of determinants positively influencing the creation of a culture of innovation alongside the phases of the innovation process are associated with the management of tacit and explicit knowledge. Having control over their knowledge allows companies to have a better understanding of their internal and external processes as well as having more information while taking their decisions. Some activities around knowledge management are linked to: (1) the development of competences in the workforce, i.e. generating tacit knowledge; (2) the acquisition of information from their internal and external routines and environments; and particularly (3) strengthening the process of identification, acquisition, assimilation, transformation and application of knowledge.

Moreover, new knowledge management strategies have to be developed considering the dynamics resultant from the implementation of Industry 4.0. Yet, Industry 4.0 refers to the fourth industrial revolution and scholars in this regard have summarized it as the inclusion of information and communication technologies at all levels of the organization [Dorst 2012, Scheer 2012]. The implementation of Industry 4.0 strategies is accelerating the changes in the market and the production of material goods is acquiring several characteristics inherent to the service sector, e.g. few to none stock or the inclusion of the customers in the development or transformation of a good. Moreover, products tend to be individualized, meaning that they are not longer following conventional life-cycle curves. Managers have lesser time for Decision-Making and planning, turning methods supported by machine learning algorithms in an extra aid for structuring and managing their operations [Henning 2013, Baum 2013]. In this regard, scholars have shown the potential of machine learning algotrithms for replacing traditional methods like just-in-time and just-in-sequence [Kim et al. 2010; Qu et al. 2015]. Therefore companies will have to rely even more on their knowledge and on the improvement of their competences not just to better manage their logistics and production processes, but also to be able to ignite and accelerate their innovation process.

Organizations have to be able to properly combine technologies to capture information from the internal and external environment in which organizations are active. This combination is key to capitalize on the information and data flowing throughout the organization and in a given scenario throughout the partners taking part on collaborative-networked innovation. Furthermore, the coordination of this data flow, the rapid conversion of data into knowledge and the proper absorption of the generated knowledge by the individuals inside the organizations constitute the truly challenge of organizations creating and fortifying their culture of innovation [Hartmann 2013, Henning 2013, Weyer et al. 2015, Kagermann 2015, Obermaier 2016].

Particularly in the context of collaborative-networked innovation, where an in-flow and out-flow of knowledge is expected among organizations [Chesbrough, Prencipe 2008], industry 4.0 technologies appear as a booster and enhancer. In this sense, industry 4.0 will allow organizations to have better control over the expected interconnections with other partners and it should enable them to shorten their reaction time to any mislead within the innovation process. Therefore, digitalized organizations will be able to harness better their participation in innovation networks and procure the creation of a better culture of innovation [Kagermann 2015, Henning 2013,

Sauter et al. 2015, Schlick et al. 2014]. In Table 2 we summarize those potential benefits of implementing technologies associated to industry 4.0 discussed by the literature that could support the creation of a culture of innovation.

Table 2. Potential benefits of implementing Industry 4.0 supporting the creation of a culture of innovation

Category	Potential benefits	Author(s)
Benefits on the innovation process	• Big Data as the next frontier for innovations • Innovation processes are accelerated • Big data as the basis for innovative value creation • Facilitate communication among internal and external partners • Fosters standardized routines among partners augmenting the understandability in cooperative innovation projects	Baum 2013; Kreutzer and Land 2016
Knowledge acquisition, creation/ generation	• Use of integrated databases available for analyses in real time gathering company's internal and external knowledge as well as structured and unstructured data sources (market and customer data) (Big Data) • Supporting and expanding human capabilities through intelligent ICT • Collection of real and virtual data from the organization and the environment allowing early forecasts based on Smart Data • Monitoring of products and processes in real time supporting decision-making activities and facilitating optimization procedures • Guarantee and increase the accessibility to a wide range of internal and external data necessary to exploit the potential of Big Data • Promote the creation of common communication channels	Henning 2013; Baum 2013; Kieninger et al. 2015
Knowledge transformation and work organization	• New forms of work organization (mobile and flexible working) • Collaborative forms of work organization • Humans supported by assistance systems • Simulation and prototyping on demand • Virtual environments for testing	Kagermann 2015; Henning 2014; Spath et al. 2013; Gorecky et al. 2014; Buhr 2015; Botthof and Hartmann 2014; Deuse et al. 2015

Moreover focusing on SMEs that seek to participate in collaborative-networked innovation, from the knowledge management perspective, as depicted in Fig 2 there are two main factors that will have to be properly managed to guarantee the cohesion and flexibility of collaborative-networked innovation actions: (1) the information generated within the network through the digitalization strategies i.e. explicit knowledge and (2) the analysis, use and absorption of such data and information from the agents belonging to network, i.e. tacit knowledge.

Firstly, the main source of explicit knowledge is associated to internal and external datasets encompassing among others customer surveys, technical reports and patents; and more generally Big Data. Big data is the collection of large amounts of data generated in a wide variety of analog and digital sources. Big Data is powered by various data sources, such as Cyber-Physical Systems (CPS) and sensors. Therefore, further applications of the industry 4.0, e.g. Smart Products or Cloud Computing are essential data sources of Big Data. In addition, this data is seen as the basis for innovative value creation. Moreover, through Big Data analysis, these data can be harnessed to support new innovation ideas, new designs, to locate potential partners or to help with the decision-making processes [Baum 2013, Kreutzer, Land 2016, Henning 2013]. This means that information and data is going to be flowing through the linkages established by organizations participating in collaborative-networked innovation, waiting to be converted into knowledge; increasing automatically the need for proper interaction between explicit and tacit knowledge [Weßels 2014].

Secondly, in order to absorb and transform information into knowledge, a process of

socialization between agents taking part on the network has to occur enabling the combination of their explicit and especially their tacit knowledge [Nonaka 2005]. Scholars have agreed that the only assets able to perform this process of socialization and combination are individuals inside those organizations. Within innovation networks, mainly employees, suppliers and customers represent these individuals. However, industry 4.0 adds to this group of agents also machines, devices, products that through the embeddedness of CPS every resource is able to socialize, analyze, use and transform information.

Finally, as depicted in Fig 2 we classified industry 4.0 applications; technologies and methods discussed by different authors as mechanisms to improve the efficiency of acquiring, assimilating and managing knowledge; based on their potential to harness internal and external knowledge and how industry 4.0 is supporting the interaction between tacit and explicit knowledge towards innovation [Nonaka, Takeuchi 1997].

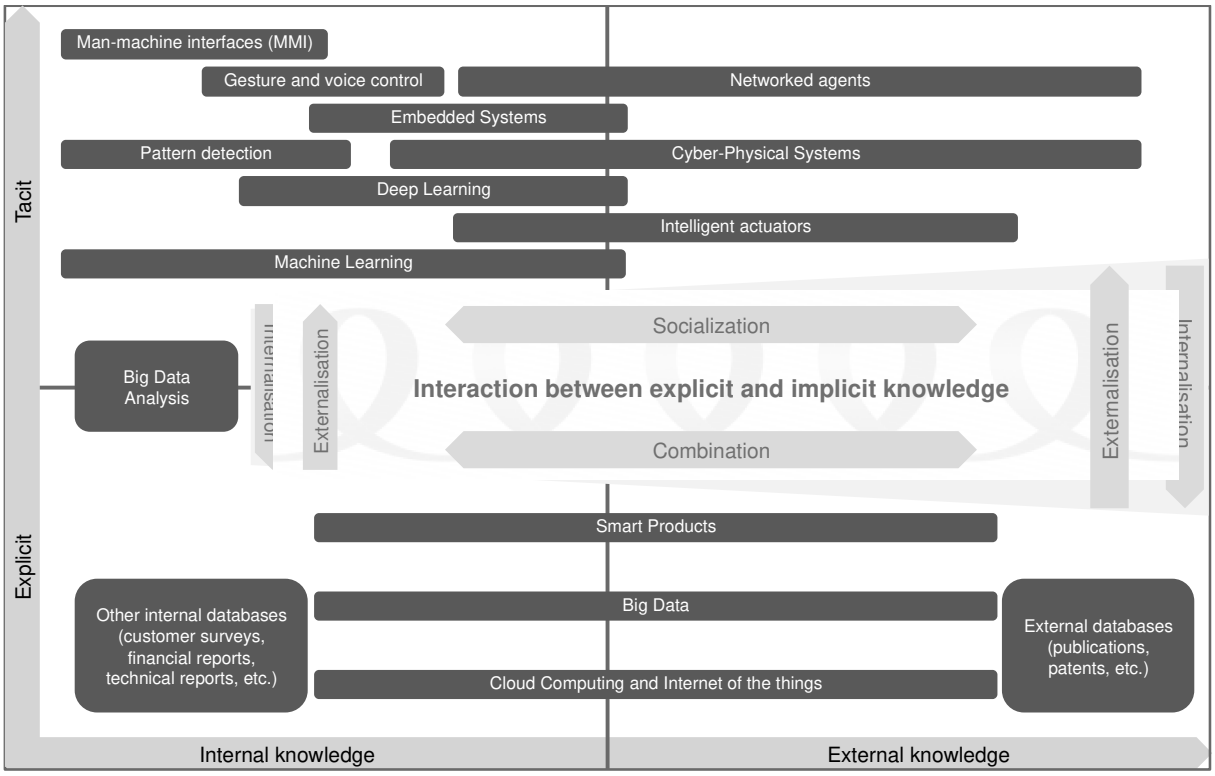

Fig. 2. Knowledge management in the context of industry 4.0

CLUSTER MANAGERS AS ENABLERS OF A CULTURE OF INNOVATION

The business administration literature has largely discussed the role of management as the function of orchestrating and coordinating the strategies within an organization. Moreover, Smith et al. [2008] found that one of the main factors influencing organizations' ability to manage innovation is directly related to their ability to manage the innovation process, mostly due to the generation of a structured innovation idea, the selection of proper techniques for idea evaluation and the definition of suitable implementation mechanisms [Smith et al. 2008]. Additionally, the literature has shown a positive correlation between SMEs' performance and their innovativeness due to their participation in innovation networks [Bougrain and Haudeville 2002; Gronum et al. 2012]. In particular, the innovation effectiveness of SMEs is positively affected by its participation in innovation networks and those ties within the network are

more beneficial when heterogeneity is higher [Gronum et al. 2012]. Furthermore, the literature shows that organizations are more prone to develop innovative traits when they belong to active industrial clusters and have access to governmental programs.

However, as discussed by Edwards et al. [2005] SMEs are facing two main challenges while participating in collaborative innovation: the "liability of smallness" and the "liability of newness" [Edwards et al. 2005]. Their success in the participation of innovation will depend on their experience and their ability to react to the challenges exposed by and intrinsic to the process of innovation. Mainly SMEs have to recognize their role within the network and at the same time make changes in their internal structures allowing them to excel in the execution of the innovation process. Hence SMEs interested in increasing their chances towards innovation, tend to join industrial associations and clusters [Donnet et al. 2010, Van Wijk et al. 2008].

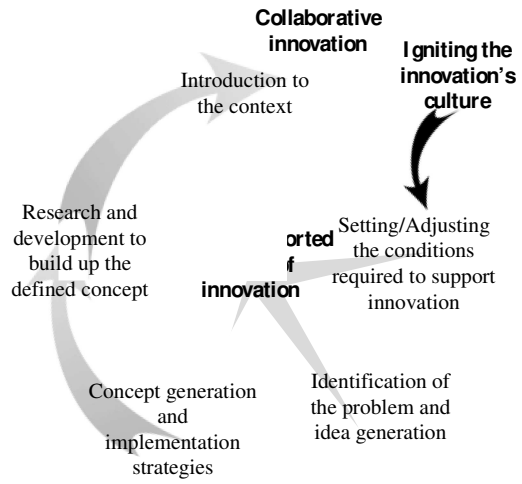

Fig. 3. The process for creating a culture of innovation

Yet, clusters are geographical concentrations of interconnected firms and associated support services. Hence, cluster managers' main goal is to promote and enable information and technology exchange within their members and articulate actions, usually innovation actions, towards economic growth. In favor of this goal, cluster organizations, acting as coordinators and managers, offer support and foster networking between their member organizations. These actions seek to accelerate innovation and capitalize on the common resources and complementary capabilities among their member organizations. Hence, clusters should act as orchestrators and help their members not only to setting the preconditions needed to ignite innovation process, but also support them along the innovation process phases. Moreover, cluster managers' activities should be oriented to guarantee the sustainability of the actions taken towards innovation by portraying the process of innovation as a cyclical event, continuously revisited by its members (Figure 3).

Cluster managers can help igniting the culture of innovation among their members by offering support services alongside the phases of the process for creating a culture of innovation. Organizations, especially SMEs, have the opportunity to gain better capabilities towards facing the challenges on each phase of the process. Based on the identified determinants of innovation, this work examined the main activities cluster mangers can offer to support their members in each phase of the process.

Phase 1: Setting/Adjusting the conditions required to support innovation

Succeeding in the generation of an innovation culture is intrinsically related to the interrelation between the management and its sub-units [Ahmed 1998]. This relationship has the potential to enhance or constrain innovation. Consequently, organization's managers will have to acquire additional abilities to help them better steer their resources, identify and acquire further resources and capabilities, manage uncertainty, build networking, foster collaboration and enable an environment that promotes innovation [Rammer et al. 2009, Van de Vrande et al. 2009, Smith et al. 2008, Bougrain and Haudeville 2002]. Moreover, organizations have to improve their communication proficiencies not just internally, but also externally by the dissemination of their

innovation interests and results [Schmiele 2012]. This aspect is especially important for SMEs seeking cooperation with peers to increase their innovation possibilities or accelerate their innovation process. Furthermore, in order to overcome financial constraints SMEs and their cluster organizations should be attentive to the governmental support measures funding innovation [Meroño-Cerdan and López-Nicolas 2013]. In this phase, cluster managers should offer services like: (1) Workshops/Seminars or further training on general management, on innovation management, on project management and on communication strategies; (2) cluster conferences on industrial developments; (3) Specific information on ongoing funding programs; (4) Consultancy on project management, tailor-made innovation strategies and funding programs.

Phase 2: Identification of the problem and idea generation

Innovations are mainly a response to new or emerging challenges. Hence, the first phase of a systematic innovation process is usually the generation or identification of potential ideas, improvements chances or further problems that can be turned into innovation [Cooper 1990, Berkhout et al. 2006]. Therefore, in this phase organizations have to procure having spaces of exchange, where new ideas can be identified, discussed and evaluated [Bougrain, Haudeville 2002, Gronum et al. 2012]. Moreover, for the selection of the proper innovation ideas, organizations will have to evaluate their competences and identify their weaknesses towards a potential execution of the innovation process [Nieves et al. 2016, Donnet et al. 2010]. Especially for SMEs this phase is highly important since it will lead to a proper characterization of the external competences that will have to be acquired from potential external partners [Van Wijk et al. 2008]. In this phase, cluster managers should offer services like: (1) Open spaces for the presentation and discussion of ideas (including ideas from other cluster members); (2) Open spaces and specialized think tanks (e.g. Technology related forums) for the exchange of ideas and knowledge of a specific area; (3) Information on industry-specific innovation developments or technology roadmaps and on industry standards, regulations, guidelines, etc.; (4) Company's analysis recognizing strengths and weakness towards the execution of innovation; (5) Process analysis to identify bottlenecks in the internal innovation process (benchmarking of the own innovation process with the industry / cluster standard) and (6) Consultancies on special methodologies and tools for structuring the innovation process.

Phase 3: Concept generation and implementation strategies

Once the relevance of the innovative idea has been estimated, a proper conceptualization has to be carried out [Cooper 1990, Berkhout et al. 2006]. In this phase especially SMEs will have to identify the suitable partners to enhance and add value to the innovation [Gronum et al. 2012, Bougrain, Haudeville 2002]. Additionally, the proper cooperation network and the strategies to develop the innovation have to be set. Furthermore, the first preliminary technological and market analysis has to be completed and the business plan for the potential innovation has to be outlined. In this phase, cluster managers should offer services like: (1) Digital expert platforms to search potential cooperation partners based on their industrial competences; (2) Searching, contacting and coordinating meetings with suitable cooperation partners; (3) Providing contact with special research centers for the development and prototyping of the concept; (4) Technology assessment, market studies/analysis and market access environment evaluation; (5) Tailor-made commercialization analysis and (6) Workshops/Seminars or further training on market analysis and on financial analysis.

Phase 4: Research and development to build up the defined concept

An innovation is considered innovation only when the product, process or service hits the market [Cooper 1990, Berkhout et al. 2006]. Hence, this phase refers to the development of the product/process/service and further planning of the resources prior to production [Cooper 1990, Berkhout et al.

2006]. Organizations will have to gain competences not just in the technology required to build up the innovation but also in the management of its implementation [Rammer et al. 2009]. Moreover, in collaborative innovations the management of intellectual property plays an important role [Kohl et al.]. In this phase, cluster managers should offer services like: (1) Tailor-made market study for the innovation; (2) Cooperation management between external technology providers and the organization; (3) External management of project implementation; (4) Administrative services (project controlling); (5) Assessment innovation projects and outcomes and (6) Workshops/Seminars or further training on managing intellectual property.

Phase 5: Introduction to the context

Disseminating the results of innovation allows organizations to gain recognition in their field of expertise and increase their chances of participating on further collaborative innovations [Schmiele 2012]. Therefore, especially for SMEs, the dissemination of the results should be set in form of a continuous improvement, focusing mainly on active learning and adaptation to lead to active idea discussions and trigger once again the innovation process. In this phase, cluster managers could support this phase by offering services oriented to: (1) disseminate innovation outcomes; (2) analyze distribution channels for the innovation; (3) create spaces for the exchange of industries' information (e.g. trade fairs); (4) design brokerage events or investor forums and (5) further training activities on exploitation and dissemination strategies.

DESCRIPTIVE ANALYSIS ACKNOWLEDGING SYNERGIES BETWEEN OFFER (CLUSTER MANAGERS) AND DEMAND (SMES)

A survey providing a descriptive analysis has been carried out aiming to gain a better insight about the interrelation between cluster organizations and SMEs towards the creation of an innovation culture. The survey was divided into 5 phases summarizing the critical points within the innovation process, where both SMEs and clusters, may gain from a proper interaction. Within this work, this interaction is studied through the activities offered by clusters to assist their members to develop the required capabilities to improve their culture of innovation. The study was launched on the 12th of January and closed on the 6th of February 2017 as part of the proposal preparation responding to the EU-Call H2020-INNOSUP-2016-2017 in the topic "cluster facilitated projects for new industrial value chains". Hence, it collected information from 16 cluster organizations and 24 SMEs located in 4 different EU member states Austria, Poland, Germany and Denmark; targeted as main partners of the project.

The structure of the questionnaire was set to compare the offer and demand based on the activities or services supporting the phases of the innovation process. Hence, each phase of the process (Figure 3) is assessed based on the services that cluster managers can offer to their members to assist them in the creation of an innovation culture. Clusters and SMEs were confronted with the same set of services. However, the question varied accordingly to the targeted group (1) cluster managers and (2) SMEs. Using the liker scale from 1 (very low) to 5 (very high), clusters were asked the question: "How do you estimate the demand from your member organizations towards the following actions/activities?" and SMEs faced the question "How do you estimate your need for the following cluster-organized actions/activities?"

As displayed in Figure 4 and Figure 5, the results of these two questions are presented as an average of the services rated by cluster managers (denoted with a triangle) and SMEs (denoted with a square). Those services were assessed using the liker scale, where values 1 and 2 were considered as low offer or demand respectively. On the contrary, those services evaluated with values 4 and 5 represented a perceived high demand from cluster managers and a high need for SMEs. Hence, the percentage of each phase depicted in Figure 3 and Figure 4 embodies the proportion

of clusters managers or SMEs, rating their demand or need for the services representing each phase as low (1 and 2) or high (4 and 5).

Besides rating the need for the services describing each innovation process phase, only SMEs were confronted with the question "In which of the following phases would you need higher support?" i.e. at process level. The intention of this question is to gain the general SMEs' understanding regarding the innovation process. In this case, without presenting SMEs with the services, but with the description of the goals that should be attempted in each phase, SMEs had to estimate their general need using the same liker scale (1 low and 5 high).

As portrayed in Figure 4, less than 50 percent of SMEs recognized a general need alongside the process suggesting that SMEs are usually underestimating the need of support during the execution of the process' phases. However, while evaluating their need based on their assessment of each of the services explaining the requirements of the phases of the process, SMEs recognize a high or very high need. This dissimilarity becomes more evident in the phases: 1 'setting/Adjusting the conditions required to support innovation', 3 'concept generation and implementation strategies' and 5 'introduction to the context', where a gap above 15 percent can be recognized. It is also important to remark that the participant clusters are offering at least 50 percent of the listed supporting activities. Nonetheless, in most of the cases the offer rates below the high demand disclosed by SMEs. This disparity is more prolonged in the phase 5 'Introduction to the context'. This could suggest two main problems: (1) there is a shortage of communication channels or (2) the general communication between clusters and SMEs is rather deficient.

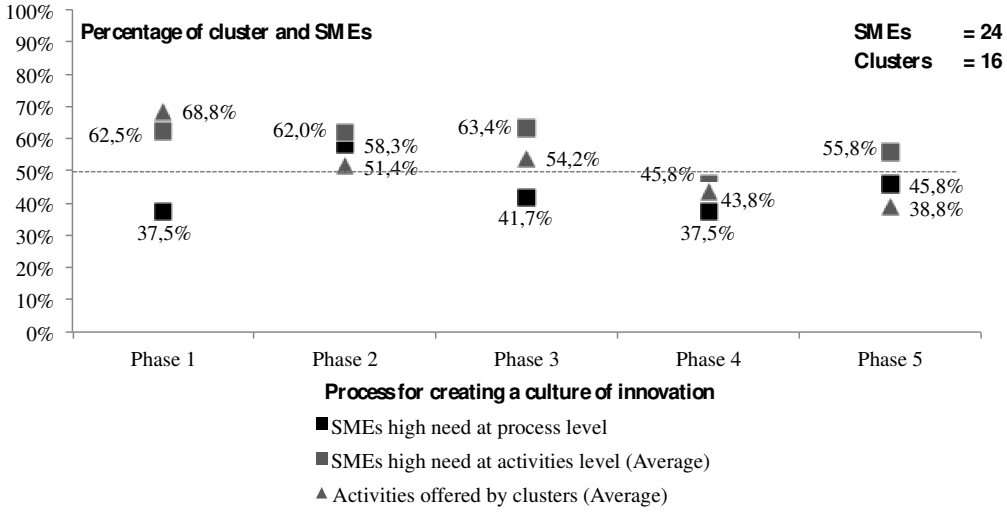

Fig. 4. Comparing offer (clusters) and demand (SMEs)

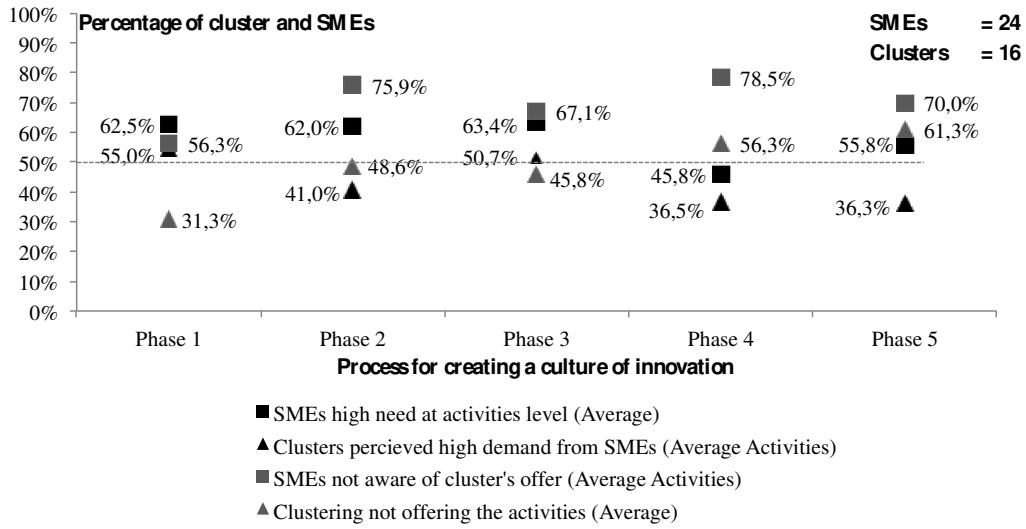

Fig. 5. Discrepancies between SMEs and Clusters

These discrepancies due to the lack of communication between SMEs and clusters become more evident when comparing the high need faced by SMEs and the offer provided by clusters. Figure 4 shows that in all phases the need reported from SMEs is higher than the clusters perceived demand. Moreover, SMEs disregard the activities provided by their clusters. Although in the 5th phase the unawareness is given due to the absence of a proper offer from the clusters, in the remaining phases, clusters are offering more activities than those acknowledged by their SMEs.

DISCUSSION

For cluster managers to assist their members, especially SMEs, is not a smooth task. Cluster managers stated that even for them getting actualized information from their SMEs members regarding needs, potentials and ambitions is usually difficult. There is not a platform that procures an interaction and cooperation between cluster and their members. To the question "Which are the main problems faced by your organization while assisting your member organizations, especially SMEs?" cluster managers vented "[SME] are often not aware of their own needs which makes it rather difficult for us to ignite innovation ideas and projects. Most of them are only concerned with financial survival and do not look far ahead". They also cited vast covered problems in the literature like the "Lack of company strategies" and the "lack of resources to undertake new projects or look into new development opportunities". SMEs, from its part, recognize the need for management services that help them improving towards the creation of a culture of innovation. However, most of them are not aware that services supporting management activities are being offered by their cluster organizations. In this regard, some of the cluster managers expressed the difficulty that represents for them to "access to [SMEs] employees". This difficulty is explained mainly by the "high cost [that this activity represents] for the cluster organization" and the lack of interest and motivation from organizations "to share and discuss new ideas". As a result two main challenges are identified: on one hand, the information acquired from cluster organizations is usually "subjective" and "out of date" and hence, cluster organizations are not being able to excel at providing accurate offers to foster innovation, especially within SMEs. On the other hand, clusters are not using effective strategies and communication channels to persuade SMEs. There is a lack of integration between of cluster and cluster members and an absence of industry 4.0 technologies supporting: (1) the innovation process, (2) the acquisitions generation and transformation of internal and external knowledge, (3) the use of Big Data supporting decision-making associated to the process of innovation and (4) the use of technologies

facilitating the interaction between partners interested in taking part of collaborative innovation strategies.

CONCLUSIONS

Finally, we suggest that cluster managers could play a more preponderant role as orchestrators of innovation by adjusting their services to the requirements of each of the innovation process phases. Moreover, this work has highlighted inconsistencies between the offer (clusters) and demand (SMEs) towards favoring the creation of a culture of innovation, especially stressing communication problems. Hence, the integration of innovative communication channels, particularly those integrating different elements of the industry 4.0 strategy might have the potential to increase the effectiveness of communication strategies between cluster managers and SMEs and thus facilitate the creation a culture of innovation in organizations, especially in SMEs.

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RÓŻNICE POMIĘDZY USŁUGAMI KLASTROWYMI A POTRZEBAMI MAŁYCH I ŚREDNICH PRZEDSIĘBIORSTW OGRANICZENIEM TWORZENIA KULTURY INNOWACYJNOŚCI INDUSTRY 4.0

STRESZCZENIE. **Wstęp:** Sposób działalność małych i średnich przedsiębiorstw (MSP) jak i ich innowacyjność jest związany z ich uczestnictwem w sieciach innowacji. Dlatego też MSP skłaniają się do dołączania się do klasterów, aby przyspieszyć swój proces innowacji, podążyć za dynamiką branży oraz zwiększyć prawdopodobieństwa swojego dostępu do zewnętrznych zasobów i wiedzy. W efekcie, promocja atmosfery współpracy poprzez wspieranie synergii między menadżerami klastru oraz MSP sprzyja tworzeniu kultury innowacyjności. Dodatkowo, rozprzestrzenianie się nowych technologii, szczególnie w obszarze Industry 4.0., sprzyja współpracy, przyspiesza rozwój innowacyjności oraz stwarza nowe wyzwania przez MSP. Jednak z drugiej strony takie postępowania ujawnia różnice pomiędzy ofertą (klastery) a popytem (MSP), mogące opóźnić tworzenie kultury innowacyjności oraz pokazuje punkty krytyczne, w których zarówno klastery jak i MSP mogłyby zyskać przy prawidłowemu współdziałaniu.

Metody: Analizie i ocenie poddano 120 praktycznych przypadków dotyczących wyznaczników innowacyjności. W oparciu o ta analizę, zaproponowano koncepcję tworzenia kultury innowacyjności. Dodatkowo w celu lepszego wglądu w relacje tworzenie kultury innowacyjności między klasterami a MSP, przeprowadzono odpowiednie badania empiryczne.
Wyniki: Analiza opisowa wykazało istotne problemy komunikacyjne i różnice pomiędzy organizacjami klasterowymi a MSP. Dodatkowo zrozumienie MSP odnośnie wymagań do budowy kultury innowacyjności jest raczej niskie. Chociaż organizacje klasterowe są ukierunkowane do dostarczania usług wspierających procesy innowacyjności ich członków, to jest zauważalna istotna różnica pomiędzy podażą i popytem w obrębie wszystkich faz zdefiniowanym w koncepcji.
Wnioski: Menadżerowie klastru mogą odgrywać ważną rolę w kształtowaniu innowacyjności poprzez dostosowanie oferowanych usług do zapotrzebowania na każdym etapie procesu innowacyjności. Co więcej, zwrócono uwagę na niezgodność pomiędzy podażą (klastru) a popytem (MSP) ograniczającą tworzenie kultury innowacyjności, szczególnie podkreślając problemy komunikacyjne. W związku z tym integracja kanałów komunikacyjnych ma kluczowy wpływ na zwiększenie kultury innowacyjności szczególnie w obrębie MSP. Podkreślono konieczność dalszych badań poszczególnych elementów w obrębie Industry 4.0 w celu zdefiniowania cech charakterystycznych kanałów komunikacyjnych, w szczególności wspierających akwizycję, asymilację i transformację wewnętrznej i zewnętrznej wiedzy w innowację.

Słowa kluczowe: wyznaczniki innowacyjności, kultura innowacyjności, sieci innowacyjności, zarządzanie klastrowe, małe i średnie przedsiębiorstwa (MSP)

Część tej pracy została zaprezentowana w formie referatu podczas konferencji "24th International Conference on Production Research (ICPR 2017)", która odbywała się w Poznaniu między 30 lipca, a 3 sierpnia 2017 roku.

DISKREPANZEN ZWISCHEN DIENSTLEISTUNGEN DER CLUSTER-ORGANISATIONEN UND NACHFRAGE VON KMU BESCHRÄNKEND AUFBAU EINER INNOVATIONSKULTUR IM KONTEXT VON INDUSTRIE 4.0

ZUSAMMENFASSUNG. Einleitung: Die Leistungsfähigkeit von KMU und ihre Innovationsfähigkeit sind mit ihrer Beteiligung an Innovationsnetzwerken verbunden. KMU neigen dazu, sich Clustern anzuschließen, um ihren Innovationsprozess zu beschleunigen, den Dynamiken der Branche standzuhalten und auf externes Wissen und Ressourcen zugreifen zu können. Die Förderung einer kooperativen Atmosphäre durch die Entwicklung von Synergien zwischen Clustermanagern und KMU kann den Aufbau einer Innovationskultur unterstützen. Darüber hinaus vereinfachen und beschleunigen moderne Informations- und Kommunikationstechnologien, insbesondere im Kontext von Industrie 4.0, die Zusammenarbeit zwischen verschiedene Innovationsagenten, wobei die Integration dieser Technologien KMU vor große Herausforderungen stellt. Dieser Beitrag identifiziert Diskrepanzen zwischen dem Angebot (Cluster) und der Nachfrage (KMU) von Dienstleistungen, die die Schaffung einer Innovationskultur unterstützen können, und hebt kritische Punkte hervor, an denen KMU und Cluster von einer angemessenen Interaktion und von modernen Technologien profitieren können.
Methode: Zunächst wurden 120 empirische Studien zur Analyse von Innovationsfaktoren ausgewertet. Auf Grundlage der ermittelten Faktoren und unter Berücksichtigung der notwendigen Beteiligung von KMU an Innovationsnetzwerken wird ein Konzept zur Unterstützung der Schaffung einer Innovationskultur in Unternehmen vorgeschlagen. Dieses Konzept wird durch die Untersuchung der potenziellen Vorteile von Industrie 4.0-Technologien ergänzt, die den Erwerb, die Anpassung und die Umwandlung von Wissen in Innovation unterstützen. Um einen besseren Einblick in die Beziehungen zwischen Cluster-Organisationen und KMU zu erhalten, wurde zusätzlich eine empirische Studie durchgeführt.
Ergebnisse: Die deskriptive Analyse zeigt, dass zwischen Cluster-Organisationen und KMU eindeutige Kommunikationsprobleme und Diskrepanzen vorliegen. Zudem ist das Verständnis von KMU für die Anforderungen zum Aufbau einer Innovationskultur eher gering. Obwohl Cluster-Organisationen Dienstleistungen zur Unterstützung der Innovationsprozesse ihrer Mitglieder anbieten, existiert eine Lücke zwischen den angebotenen und nachgefragten Dienstleistungen in allen definierten Phasen.
Fazit: Wir schlagen vor, dass Clustermanager eine überwiegende Rolle als Architekten und Regisseuren von Innovationen spielen sollen, indem sie ihre Dienstleistungen an die Anforderungen der einzelnen Phasen des Innovationsprozesses anpassen. Darüber hinaus zeigt die Untersuchung Diskrepanzen zwischen dem Angebot (Cluster) und der Nachfrage (KMU) von Dienstleistungen auf und hebt insbesondere Kommunikationsprobleme zwischen beiden Parteien vor. Die identifizierten Probleme behindern die Schaffung einer Innovationskultur. Daher ist die Integration innovativer Kommunikationskanäle zwischen Clustermanagern und KMU von entscheidender Bedeutung für die Förderung einer Innovationskultur in den entsprechenden Organisationen. In weiteren Untersuchungen sollte die

unterstützende Wirkung insbesondere von Technologien im Kontext von Industrie 4.0 untersucht werden, um die Eigenschaften innovativer Kommunikationskanäle zu definieren, insbesondere diejenigen, die den Erwerb, die Assimilation und die Umwandlung von internem und externem Wissen in Innovation unterstützen.

Codewörter: Innovation, Innovationskultur, Innovationsnetz, Clustermanager, KMU

Der Teil dieser Arbeit wurde in Form des Vortrag während der Konferenz "24th International Conference on Production Research (ICPR 2017)", die in Poznan am 30 Juli-3 Aug 2017 stattfand, präsentiert.

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