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Connecting the dots: examining the link between creativity-enhancing methods and open innovation in the EU business landscape

Maciej Zastempowski
Faculty of Economic Sciences and Management, Nicolaus Copernicus University in Torun, Torun, Poland
Salah Koubaa
Hassan II University, Casablanca, Morocco, and
Krzysztof Krukowski
University of Warmia and Mazury in Olsztyn, Olsztyn, Poland

Abstract

Purpose – This study investigates whether creativity-enhancing methods – specifically brainstorming sessions, cross-functional work groups or teams, and staff job rotation – positively influence the implementation of open innovations (product and process) in companies across the European Union.

Design/methodology/approach – The empirical analysis is based on microdata from the 2018 Community Innovation Survey (CIS), encompassing 48,666 firms from eight EU member states. Logistic regression models were employed to examine the impact of selected creativity-enhancing practices on open innovation adoption. The robustness of results was tested using bootstrap replications and country-level analyses.

Findings – The study reveals that brainstorming and cross-functional teams significantly increase the likelihood of implementing open innovation. Surprisingly, staff job rotation exhibits a negative association with open innovation outcomes. These findings remain robust across different model specifications and national contexts.

Practical implications – Managers seeking to promote open innovation should invest in structured idea-generation techniques and cross-departmental collaboration while carefully assessing the unintended consequences of job rotation schemes.

Originality/value – This is one of the first large-scale empirical studies to systematically assess the relationship between creativity-stimulating organisational practices and open innovation implementation. It contributes to bridging the gap between creativity theory and innovation management, offering new insights into how firms can operationalise ideation in support of open innovation strategies.

Keywords Creativity, Open innovation, Brainstorming, Cross-functional work teams, Staff job rotation

Paper type Research article

Introduction

We cannot solve all problems using available information and basic logic alone. Many of them require fresh perspectives or unconventional yet clever solutions. We call it creativity: solving problems through novel combinations of ideas or actions (Csikszentmihalyi, 1996).

According to Guilford's (1967) theory of intelligence, we may base problem-solving on two ways of thinking: convergent and divergent thinking. The first sees a problem as having only one solution, to which all reasoning based on knowledge and logic ultimately leads (Ciccarelli & White, 2015). In contrast, the second generates many different ideas or possibilities beginning from one starting point.

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Ciccarelli and White (2015) note that creativity usually comes from divergent thinking. Therefore, it is less prone to common problem-solving errors such as functional fixation, mental attitude, and the confirmation effect. Of course, some people, and thus organizations, are naturally more creative. Notably, people can develop creativity, as indicated, for example, by Dyer, Gregersen, and Christensen (2008).

Several theories describe the sources of creativity and ways to stimulate it. Let us consider a few prominent ones. Guilford's (1967) theory of intelligence introduced the influential concepts of fluid thinking, i.e. the ability to generate many ideas, and flexible thinking, i.e. the ability to change perspectives, as key aspects of creativity. Gardner's (2011) multiple intelligences theory is also interesting as it suggests that there are different types of intelligence, and creativity can manifest itself in various ways depending on an individual's specific intelligence, such as artistic, musical, linguistic, etc. Sawyer's (2016) flat organizational structure theory also provides essential theoretical foundations, indicating that we may understand creativity as the result of interactions among many individuals in a flat organizational structure, where ideas and information circulate and combine freely. Similarly, the Osborn-Parnes creative problem-solving process theory posits that people may enhance creativity by defining problems, generating ideas, selecting, and implementing the best solutions (Parnes, 1967).

As mentioned, people can stimulate creativity. Based on the indicated theories, the literature suggests various methods that may contribute to the development of creativity. Here, we may indicate idea generation techniques related to Guilford's (1967) theory, such as brainstorming (Sutton & Hargadon, 1996), mind mapping (Davies, 2011), or word association techniques (Guilford, 1967). These can help in generating creative ideas, or with cross-functional work groups or teams (Schoner, Gorbet, Taylor, & Spencer, 2007), and staff job rotation (Revilla & Rodríguez-Prado, 2018), i.e. they emphasize the role of interactions among people involved in creativity, and thus relate to Sawyer's (2016) theory.

Creativity is also one of the crucial foundations on which contemporary companies try to build their innovation (both closed and open) (Revilla & Rodríguez-Prado, 2018). In turn, this innovation is the main driving force for companies to prosper, grow, and sustain high profitability (Christensen, 1997). The open innovation model popularized by Chesbrough (2003), which urges firms to open their innovation processes and combine internal and external technologies to generate value, appears closely linked to firms' ability to do so effectively (Dyduch, Chudziński, Cyfert, & Zastempowski, 2021) to develop the creativity of their employees. Yström, Aspenberg, and Kumlin (2015) even state that increasing connectivity between multiple partners, the new paradigm of open innovation, stimulates creativity. Although previous studies have shown that idea generation positively predicts their implementation, the relationship between creativity and innovation still requires clarification (Revilla & Rodríguez-Prado, 2018).

Previous research (Dahlander & Gann, 2010; Revilla & Rodríguez-Prado, 2018; Liao & Tsai, 2019; Ungureanu, Cochis, Bertolotti, Mattarelli, & Scapolan, 2020; Hofstetter, Dahl, Aryobsei, & Herrmann, 2021; Engelsberger, Halvorsen, Cavanagh, & Bartram, 2022) and the systematic literature review presented below suggest that studies conducted so far on the relationship between methods of stimulating creativity and the innovativeness of enterprises have provided results that are not precise enough. In terms of the relation with open innovations, this constitutes a little-known research gap.

Given the assumption that divergent thinking stimulates creativity, an important research question emerges: Do creativity-enhancing methods positively influence the implementation of open innovation? We focused on three creativity-enhancing methods, i.e. brainstorming sessions, cross-functional work groups or teams, and staff job rotation. Moreover, we understand open innovations following the fourth version of the Oslo methodology (OECD & Eurostat, 2018) as implemented open product and process innovations. We tried to shed some additional light on this problem.

To present an answer based on empirical data, we decided to use microdata from Eurostat's Community Innovation Survey (CIS) in 2018. Notably, using CIS data has a long history in researching various innovation-related issues (Revilla & Rodríguez-Prado, 2018; García-Piqueres & García-Ramos, 2022).

We used logistic regression to analyze the relationship between methods that stimulate new ideas or creativity and the introduction of open innovation in European Union (EU) companies. We estimated the models based on a dataset (containing 48,666 observations) from the following eight EU countries: Bulgaria, Croatia, Estonia, Greece, Hungary, Lithuania, Portugal, and Romania.

The principal conclusion is that using methods to stimulate new ideas and creativity, such as brainstorming sessions, and cross-functional work groups or teams, increases the likelihood that EU companies will introduce open innovation. In the case of using staff job rotation, this probability decreases.

The remainder of the article is structured as follows. The next section presents a literature review covering key theoretical perspectives on creativity, creativity-enhancing methods, and open innovation. Subsequently, the materials and methods section describes the data, variables, and econometric approach based on the 2018 Community Innovation Survey. The results section reports the outcomes of the logistic regression models and robustness checks, including country-level analyses. Finally, the discussion and conclusions section interprets the findings, outlines their theoretical and practical implications, and identifies promising avenues for future research.

Literature review

Creativity

Viewed from a theoretical perspective, creativity is currently characterized by great diversity. Creativity is a multifaceted and dynamic concept that scholars have defined and understood in various ways, especially in contemporary discussions. Consequently, as Kālis and Roke (2013) suggest, no single universally accepted definition of creativity exists. For example, Csikszentmihalyi (1996) defines creativity as "any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one." In turn, Amabile (2012) suggests that "creativity is the production of novel and useful ideas in any domain of human activity, from science and art to business and everyday life." This is quite closely related to the variety of instruments designed to measure this complex phenomenon. Commonly known complex models of creativity have been developed by Sternberg (2006), Amabile (2012), Jellen and Urban (1989), and Csikszentmihalyi (1996).

Notably, creativity, which constitutes an essential part of cognitive, social, and emotional activity, is also an integral part of creating innovation. The scale of ideational behaviour developed by Runco, Plucker, and Lim (2001) evidences this.

Assuming that creativity, as a multifaceted and dynamic concept, manifests itself in the ability to combine existing ideas, problem-solving, divergent thinking, adaptability, and collaboration, we should ask what methods we can use to develop creativity.

Usually, creativity comes from divergent thinking (Guilford, 1967; Ciccarelli & White, 2015), which people can develop and stimulate (Dyer *et al.*, 2008). This involves primarily creating an environment and adopting strategies that encourage the generation of new and innovative ideas. Among the possible techniques or methods used to foster creativity, we may name brainstorming (Sutton & Hargadon, 1996), mind mapping (Davies, 2011), SCAMPER (Eberle, 1972), creative problem-solving (Eberle, 1972), design thinking (Brown, 2008), lateral thinking (Waks, 1997), divergent and convergent thinking Guilford's (1967), cross-disciplinary collaboration (Schoner *et al.*, 2007), and staff job rotation (Revilla & Rodríguez-Prado, 2018).

Based on Sawyer's (2016) theory of flat organizational structure, which emphasizes the importance of interaction and cooperation between units in an organization as a means of stimulating creativity, we decided to focus on the following three methods of stimulating creativity: brainstorming sessions, cross-functional work groups or teams, and job rotation. The first is brainstorming, a technique often used in organizations to generate creative ideas (Osborn, 1942). Regular brainstorming sessions involving employees from different functional areas can facilitate the exchange of diverse ideas and perspectives (Revilla & Rodríguez-Prado, 2018). The second method, cross-functional work teams, is an approach that promotes cooperation, knowledge sharing, and the integration of various points of view (Ungureanu *et al.*, 2020). The third method, job rotation between different functional areas, encourages employees to gain experience in different areas of an organization, which may lead to a broader perspective and the exchange of ideas.

Considering that Eurostat research conducted as part of the CIS 2018 used the three creativity-enhancing methods mentioned above, in the following section of the literature review, we focus on these methods.

Open innovation

Recent research into innovation strongly indicates a growing share of knowledge obtained from outside the organization (West & Bogers, 2014). It explicitly indicates that the openness of an enterprise to external sources of knowledge constitutes an essential factor influencing the enterprise's innovation level (West & Bogers, 2014; Bogers, Foss, & Lyngsie, 2018).

The open innovation paradigm challenges the traditional closed or internal innovation model, which relies solely on a company's internal resources and expertise. Instead, open innovation encourages organizations to seek external ideas, collaborate with partners, and leverage external resources to drive innovation (Chesbrough, 2003).

From the theoretical point of view, open innovations are based on several approaches. Of fundamental importance here is Chesbrough's (2003) open innovation model, which suggests that organizations should actively acquire external knowledge, as well as allow their unused internal knowledge to flow outward to benefit others. This approach involves inbound open innovation (external knowledge coming in) and outbound open innovation (internal knowledge going out).

The extension to this are Chesbrough and Brunswicker's (2013) Four Modes of Open Innovation. The develop the concept of open innovation by proposing four modes of open innovation, i.e. inbound and outbound open innovation, coupled open innovation, and integrated open innovation.

Let us also mention the concept of crowdsourcing, popularized by Howe (2009) and Boudreau and Lakhani (2013), which involves harnessing the collective intelligence and skills of many people, often from the online community, to generate ideas, solve problems, or connect.

Another interesting perspective is von Hippel's (2005) theory of user innovation, which posits that innovative users, among others, "lead users," who face specific unmet needs, can develop novel solutions and innovations with broader applicability. Companies can tap into these lead users to gain valuable insights and co-create products or services. This theory challenges the traditional innovation model, often focusing on manufacturers and producers as the primary drivers of innovation.

Moreover, open innovations strongly relate to the Resource-Based View (RBV) theory (Barney, 1991), dynamic capabilities (Teece, Peteraf, & Leih, 2016), and the absorptive capacity theory (Cohen & Levinthal, 1990). Notably, RBV aligns with open innovation theory in several ways. First, open innovation emphasizes acquiring valuable external resources, such as knowledge and technology, to complement internal capabilities and enhance a firm's resource base. Second, it involves effectively combining internal and external resources to drive innovation in products, services, and processes. Furthermore, open innovation is closely linked to dynamic capabilities theory, highlighting a firm's ability to adapt, reconfigure, and deploy resources in response to changing market conditions (Teece *et al.*, 2016). Firms practicing open innovation tend to develop dynamic capabilities for the effective management and integration of external resources. Absorptive capacity, which focuses on an organization's ability to identify, assimilate, and apply external knowledge effectively, is also closely related to open innovation. As Cohen and Levinthal (1990) suggest, only organizations with high absorptive capacity can make the most of external innovations and knowledge.

At the enterprise level, factors influencing open innovation include, among others: absorptive capacity (de Faria, Lima, & Santos, 2010), organizational design (Foss, Lyngsie, & Zahra, 2013), employee diversity (Bogers *et al.*, 2018), leadership (Fleming & Waguespack, 2007), strategic human resource management (Engelsberger *et al.*, 2022), and organizational culture.

Considering the innovation typology resulting from the Oslo methodology (OECD & Eurostat, 2018) and Chesbrough's (2003) open innovation model, we subsequently focused on the effects of open innovation processes, i.e. on implemented open product and process innovations.

Links between creativity and open innovation

We used the systematic literature review method to present the current state of research in creativity and open innovation. We used Scopus as the bibliometric database. We based the search on the following terms: "creativity AND 'open innovation'" in the "Article title, abstract, and keywords" field, which produced 292 results (as of September 1st, 2024). In subsequent steps, we narrowed down the results according to the following criteria: (1) 2012–2022 (244 results); (2) document type – article (121); (3) publication stage: final (114); (4) source type – journal (113); (5) subject area – Business, Management and Accounting; Social Sciences; Economics, Econometrics and Finance, Computer Science, Engineering, and Decision Sciences (102); (6) language – English (100). Below, we present the key conclusions.

The ability to generate new ideas belongs to ideation, which is the creative process of generating, developing, and communicating new ideas. An idea is a fundamental element of thought, which can be visual, concrete, or abstract (Jonson, 2005). As such, business practice has used ideation for many years (Hofstetter *et al.*, 2021). Osborn (1942) proposed brainstorming as an effective way to increase the number and quality of ideas generated in groups. Generally, it lists all the ideas a group presents in response to a given problem or question. Revilla and Rodríguez-Prado (2018) noted that brainstorming stimulates divergent thinking and thus contributes to innovation. Hofstetter *et al.* (2021) noted that people use brainstorming, a popular way for companies to generate ideas, in open competitions. Interestingly, Hofstetter *et al.* (2021) pointed out that competition participants' knowledge of many competing ideas can harm rather than stimulate creative activity, thus hindering the emergence of innovation. In turn, Dahlander and Gann (2010) note that the ideas of others, usually resulting from brainstorming, can serve as the main advantage of open innovation, as they favor the emergence of incremental and cumulative innovations. Click or tap here to enter text.Meanwhile, researching eco-innovation strategy, Liao and Tsai (2019) suggest that due to the interactions during brainstorming sessions, these can help generate novel and potentially valuable ideas that may result in eco-innovation. On the other hand, Epstein, Kaminaka, Phan, and Uda (2013) defined the ability to use brainstorming to maximize creative efficiency as one of the eight critical managerial competencies. The conclusions described by Lynch, Murthy, and Engle (2009) are also interesting as they suggest that the effectiveness of brainstorming is much higher for teams conducting electronic brainstorming compared to teams using traditional face-to-face brainstorming. The above prompted the formulation of the following hypothesis:

H1. Brainstorming sessions positively impact the implementation of open innovation.

Cross-functional or multidisciplinary work teams play an important role in new product development. Revilla and Rodríguez-Prado (2018) indicate that teamwork promotes the development of convergent thinking and the ability to discuss conflicting ideas. Bunduchi's (2009) research shows that cross-functional teams increase creativity in new product development, thus leading to shorter development times and greater product innovation. Various studies conducted so far have confirmed that the creation of cross-functional teams in new product development is associated with increased process efficiency (Brown & Eisenhardt, 1995), development speed (Tatikonda & Montoya-Weiss, 2001), overall project success (McDonough III, 2000), and overall organizational performance (Song, Montoya-Weiss, & Schmidt, 1997). Scholars also believe believed that cross-functional teams primarily generate a greater variety of information, leading to greater creativity in solving problems (Griffin, 1997). Other studies, such as Wei, Thurasamy, and Popa (2018), show that in contemporary global virtual teams, team climate, expressed through cohesion, confidence, and members' knowledge, skills, and abilities, significantly shapes individual creativity. In turn, Ungureanu *et al.* (2020) emphasize another feature of multidisciplinary teams that is essential for their creativity and innovation, that is, temporary assignments to development projects. This feature may encourage members of cross-functional teams to be more creative, as well as willing to overcome rigid roles and organizational structures. As a consequence, we put forward another hypothesis:

H2. Cross-functional work groups or teams positively impact the implementation of open innovation.

The literature indicates several organizational benefits associated with the third method of stimulating employees' creativity, namely job rotation. Revilla and Rodríguez-Prado (2018) suggested that job rotation encourages convergent thinking and, consequently, the ability to discuss conflicting ideas. Lundvall and Nielsen (2007) believe that job rotation is a characteristic feature of learning organizations, which in turn can contribute to increasing their innovativeness. Söderquist (2006) notes that job rotation can serve to improve the sharing of tacit knowledge. Song, van der Bij, and Weggeman (2006) suggest that job rotation generally contributes to creating new knowledge, while Fægri, Dybå, and Dingsøyr (2010) emphasize that job rotation can also improve performance in cross-functional teams. In turn, Engelsberger *et al.* (2022) indicate that job rotation, as one of the elements of strategic human resource management, should serve to encourage the sharing and acquisition of knowledge inside and outside the organization, and thus to support the efficiency of open innovation. In light of the above, we formulated another hypothesis:

H3. Job rotation positively impacts the implementation of open innovation.

Figure 1 illustrates the proposed hypotheses resulting from a literature review in the form of the theoretical model.

Materials and methods

Data collection

To examine the link between creativity-stimulating methods and the adoption of open innovation in EU companies, we used data from the 2018 Community Innovation Survey (CIS). Conducted biennially since 1992, the CIS explores various innovation aspects in EU enterprises using a harmonized questionnaire (HDC) developed by Eurostat. The survey covers EU Member States, EFTA, and EU Candidate Countries. The 2018 HDC is available on the CIRCABC website (Eurostat & European Commission, 2022).

Notably, the HDC questionnaire's design excludes potential common method bias as much as possible. Based on the Harman single-factor test, numerous previous studies have confirmed that common method error is unlikely for CIS data (Leiponen & Helfat, 2010; Klingebiel & Rammer, 2014).

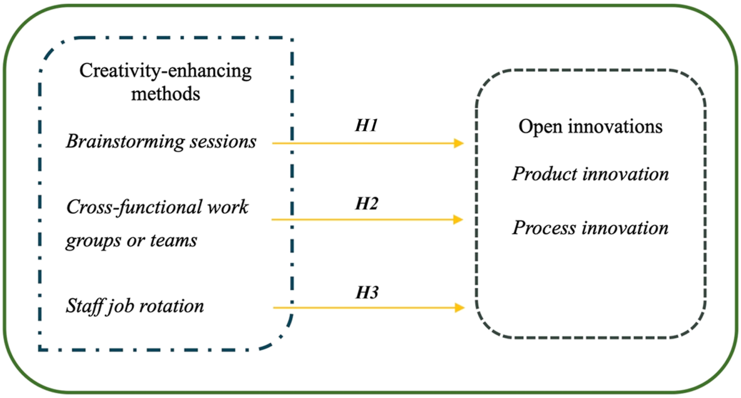

Figure 1. Theoretical model. Source: Own elaboration

Research sample characteristics

The research used the 2018 CIS microdata set available in the form of a scientific-use file, which provides data about the following 14 EU member countries: Bulgaria, Croatia, Czechia, Estonia, Germany, Greece, Hungary, Latvia, Lithuania, Malta, Portugal, Romania, Slovakia, and Spain. The analyzed data set included 100,115 observations. Since the question about creativity-stimulating methods (point 2.11 in the HDC) was not obligatory but optional, the final micro data set amounted to 48,666 observations from 8 EU countries, i.e. Bulgaria, Croatia, Estonia, Greece, Hungary, Lithuania, Portugal, and Romania. Table 1 presents countries characteristics.

Analysis of Table 1 shows that over 50% of the companies belonged to the manufacturing sector (C). The second largest group was wholesale and retail trade companies (15.9%), and the third was transport and storage (11.2%). The national percentage exceeded 3% in all countries except Croatia and Portugal. The sample comprised 92.5% small and medium-sized firms, and 7.5% larger companies.

Variables

Open innovations. Using Chesbrough's (2003) concept, i.e. that open innovation emerges in cooperation with the external environment, we considered the following CIS 2018 variables (Eurostat & European Commission, 2022) related to the introduction of product and process innovations, based on the fourth version of the OSLO methodology (OECD & Eurostat, 2018).

(1) Product innovations:

- DEVE_PRD_ENT_OTH – the original HDC question was: "Product innovations developed by your enterprise together with other enterprises or organizations."
- DEVE_PRD_ADP_ENT_OTH – "Product innovations developed by your enterprise by adapting or modifying goods or services originally developed by other enterprises or organizations."
- DEVE_PRD_OTH – "Product innovations developed by other enterprises and organizations."

(2) Process innovations:

- DEVE_PCS_ENT_OTH – "Process innovations developed by your enterprise together with other enterprises or organizations."

Table 1. Sample structure

	NACE												
Country	B	C	D	E	F	G	H	J	K	M	Q	Total	%
Bulgaria	120	7,479	133	254	0	3,167	2,109	1,240	428	565	0	15,495	*31.84*
Croatia	37	1,315	49	226	0	250	243	251	102	178	0	2,651	*5.45*
Estonia	24	517	29	44	0	78	114	92	56	65	0	1,019	*2.09*
Greece	53	1,809	39	166	0	402	571	406	226	270	0	3,942	*8.10*
Hungary	65	4,156	109	176	0	1,047	813	482	185	344	0	7,377	*15.16*
Lithuania	27	927	54	86	223	243	292	218	95	215	0	2,380	*4.89*
Portugal	98	4.216	41	271	32	1,424	630	499	261	664	88	8,224	*16.90*
Romania	124	4.073	123	333	0	1,120	671	495	301	338	0	7,578	*15.57*
Total	548	24,492	577	1,556	255	7,731	5,443	3,683	1,654	2,639	88	48,666	
%	*1.13*	*50.33*	*1.19*	*3.20*	*0.52*	*15.89*	*11.18*	*7.57*	*3.40*	*5.42*	*0.18*		
								Firm size		Small		32,142	*66.05*
										Medium		12,865	*26.44*
										Large		3,659	*7.51*
										Total		48,666	

Source(s): Own elaboration

- DEVE_PCS_ENT_ADP – "Process innovations developed by your enterprise by adapting or modifying goods or services originally developed by other enterprises or organizations."
- DEVE_PCS_OTH – "Process innovations developed by other enterprises and organizations."

Noteworthy, we treated "independent enterprises plus other parts of your enterprise group (subsidiaries, sister enterprises, head office, etc.)" as other enterprises (Eurostat & European Commission, 2022). In turn, we understood "universities, research institutes, non-profits, etc." as other organizations (Eurostat & European Commission, 2022). We measured all these variables on a dichotomous scale.

For further analysis based on econometric modelling, we created three dummy variables based on the following formulas:

$$y_1 = \mathrm{DEVE\_PRD\_ENT\_OTH} + \mathrm{DEVE\_PRD\_ADP\_ENT\_OTH} + \mathrm{DEVE\_PRD\_OTH} \quad (1)$$

$$y_2 = \mathrm{DEVE\_PCS\_ENT\_OTH} + \mathrm{DEVE\_PCS\_ENT\_ADP} + \mathrm{DEVE\_PCS\_OTH} \quad (2)$$

$$y_3 = y_1 + y_2 \quad (3)$$

Consequently, we obtained variables that we measured on an ordinal scale from 0 to 3 (y_1 and y_2) and from 0 to 2 (y_3), and which we then recoded into a dichotomous variable. Finally, we prepared three explanatory variables:

(1) Open product innovation (y_1) – which takes the value 1 if the firm introduced any open product innovation in the years 2016–2018, and 0 if this was not the case;

(2) Open process innovation (y_2) – which takes the value 1 if the firm introduced any open process innovation in the years 2016–2018, and 0 if this was not the case;

(3) Open product and process innovation (y_3) – which takes the value 1 if the firm introduced both open product and open process innovations in 2016–2018.

Creativity-enhancing methods. In terms of explanatory variables, we considered the following three CIS 2018 variables regarding the use of methods stimulating new ideas or creativity among employees (Eurostat & European Commission, 2022).

(1) Brainstorming sessions (x_1) – the original HDC statement of MORG_BRNT was: "Regular brainstorming sessions for staff to think about improvements that could be made within the business."

(2) Cross-functional work groups or teams (x_2) – MORG_CF_WG – "Cross-functional work groups or teams (combined across different working areas or functions)."

(3) Job rotation (x_3) – MORG_JROT – "Planned job rotation of staff across different functional areas."

We measured these methods on a degree of importance scale (0 – Not important, 1 – Low, 2 – Medium, 3 – High).

Control variables. We used four parameters suggested in the literature as potentially influencing innovation: enterprise size, export activity, R&D expenditures, and sector of business activity (Stojčić, 2021).

The first was company size, measured by the number of employees. Based on the CIS variable – SIZE CLASS, we created the following ordinal variable (1–10–49 employees, 2–50–249, 3 – over 250).

(1) Size (x_4) – number of employees.

The second variable was doing export business. We created this variable based on the type of geographical market in which the studied enterprises realize their turnover. We used two CIS variables:

(1) TUR_EU_EFTA – the original HDC statement was: "% turnover from customers located in other EU and EFTA countries."

(2) TUR_NEU_NEFTA – "% turnover from customers not located in EU and EFTA."

In the next step, we created the x_5 variable based on the following formula:

$$\text{Export}\,(x_5) = \text{TUR\_EU\_EFTA} + \text{TUR\_NEU\_NEFTA} \tag{4}$$

Finally, we recorded this variable into a dichotomous scale (any turnover greater than 0 was coded as 1).

The third variable was R&D expenditure. We used the following two CIS variables:

(1) EXP_INNO_RND_IH_rat – the original HDC statement was: "Expenditure in R&D performed in-house - share of real turnover (%)."

(2) EXP_INNO_RND_CONTR_OUT_rat – "R&D expenditure contracted out to others (including enterprises in own enterprise group) - share of real turnover (%)."

In both cases, we re-coded these variables on a dichotomous scale (we coded any R&D expenditures greater than 0 as 1), creating two dummy variables:

(1) in house R&D (x_6),

(2) external R&D (x_7).

The fourth variable was economic activity. We analyzed two possible activities, industry, and services. Based on the CIS variable representing the type of economic activity (NACE codes), we created the following dummy variable:

(1) Industry (x_8).

This variable took the value "1" if the enterprises belonged to NACE's B, C, and F sections. In such a situation, the second variable, service, was unnecessary. If the variable industry (x_8) takes the value 0, it is evident that a given respondent belongs to the service category of economic activity. In this case, the variable service is redundant. It becomes a reference category.

Table 2 displays the descriptive statistics of all the analyzed variables.

Method

Due to the dichotomous nature of all the explained variables, we used logistic regression as an econometric model. We can write this as:

$$logit\,(p_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} \tag{1}$$

wherein $logit\,(p_i)$ is denoted $\ln \frac{p_i}{1-p_i}$. The subject of estimation is the parameters $\beta_0, \beta_1, \beta_2, \ldots, \beta_k$ being elements of the vector β.

As an estimation technique, we applied the maximum likelihood method, while we used odds ratios (OR) to interpret the results. We made the calculations using STATA.16.1 software.

Table 2. Descriptive statistics of the analyzed variables

Variables	% Of "yes'	"Mean	Std. dev	Variance	Skewness	Kurtosis	Min	Max
y_1	15.08	0.151	0.358	0.128	1.952	4.909	0	1
y_2	15.42	0.154	0.361	0.130	1.915	4.669	0	1
y_3	21.41	0.214	0.401	0.168	1.394	2.944	0	1
x_1	63.75	0.637	0.481	0.231	−0.572	1.327	0	1
x_2	64.01	0.640	0.479	0.231	−0.583	1.341	0	1
x_3	62.44	0.624	0.484	0.235	−0.513	1.263	0	1
x_4	–	1.414	0.627	0.393	1.239	3.401	1	3
x_5	58.03	0.580	0.493	0.244	−0.325	1.105	0	1
x_6	9.98	0.099	0.299	0.089	2.670	8.130	0	1
x_7	3.55	0.354	0.185	0.034	5.023	26.232	0	1
x_8	51.98	0.519	0.499	0.249	−0.079	1.006	0	1

Source(s): Own elaboration

Results

First, we examined the possibility of common method variance (CMV) bias. We used the one-way Harman's test, with the results showing that a single factor explains 33.1% of the variance, so there was no CMV bias.

Table 3 displays the correlations between the variables. Most of the coefficients were statistically significant. However, the coefficients among the explanatory variables were consistently below 0.5, and the variance inflation factors were below 10 in all cases (the highest variance inflation factor was 2.90). Thus, collinearity as not a threat.

We first estimated logistic regressions using all the observations, and later separately for the eight analyzed EU countries. Table 4 shows the results of the overall logistic model estimations for y_1, $y_{2,}$ and y_3. Meanwhile, Table 5 shows the odds ratios.

The performed reliability tests indicated the significance of each of the models (LR χ^2, Prob > χ^2). To confirm the quality of the fit of the estimated models to the data, we checked the accuracy of forecasting on their basis (Table 6). We based this prediction on the estimated probability $\widehat{p_i}$, a function of $F(x_i'\widehat{\beta})$. Scholars usually assume that if $F(x_i'\widehat{\beta}) \geq 0.5$, in which case the prediction equals $\widehat{y_i} = 1$. If $F(x_i'\widehat{\beta}) < 0.5$, then the forecast from the model is equal to $\widehat{y_i} = 0$.

Table 3. Correlation matrix

Variables	y_1	y_2	y_3	x_1	x_2	x_3	x_4	x_5	x_6	x_7
y_1	1									
y_2	0.523***	1								
y_3	0.807***	0.818***	1							
x_1	0.210***	0.212***	0.238***	1						
x_2	0.211***	0.208***	0.239***	0.480***	1					
x_3	0.143***	0.138***	0.157***	0.451***	0.464***	1				
x_4	0.121***	0.164***	0.161***	0.183***	0.195***	0.153***	1			
x_5	0.146***	0.132***	0.162***	0.156***	0.142***	0.091***	0.193***	1		
x_6	0.320***	0.288***	0.334***	0.192***	0.185***	0.125***	0.153***	0.168***	1	
x_7	0.241***	0.241***	0.253***	0.125***	0.118***	0.083***	0.108***	0.086***	0.392***	1
x_8	0.002	−0.320***	0.009**	−0.008**	0.004	0.065***	0.095***	0.147***	0.043***	0.001

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01

Source(s): Own elaboration

Table 4. Logistic regression results for open product, open process and open product and process innovation

Variables	y_1 Coef	S.E.	y_2 Coef	S.E.	y_3 Coef	S.E.
x_1	0.642***	0.060	0.738***	0.057	0.638***	0.049
x_2	0.814***	0.061	0.719***	0.058	0.762***	0.050
x_3	−0.078*	0.043	−0.136***	0.042	−0.152***	0.038
x_4	0.135***	0.021	0.367***	0.020	0.267***	0.019
x_5	0.538***	0.031	0.454***	0.030	0.504***	0.027
x_6	1.463***	0.038	1.166***	0.038	1.432***	0.036
x_7	1.046***	0.063	1.171***	0.062	1.388***	0.069
x_8	−0.182***	0.028	−0.365***	0.028	−0.215***	0.025
_cons	−3.531***	0.048	−3.616***	0.046	−3.088***	0.040
Log pseudolikelihood	−17429.153		−17867.43		−21314.12	
Wald χ^2 (8)	5218.22		4828.84		5692.75	
Prob > χ^2	0.0000		0.0000		0.0000	
Pseudo R^2 McFadden	0.1557		0.1462		0.1568	
Pseudo R^2 Nagelkerke	0.2160		0.2050		0.2330	

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01. Robust standard error in S.E. column
Source(s): Own elaboration

Table 5. Odds ratios

Variables	y_1 OR	S.E.	y_2 OR	S.E.	y_3 OR	S.E.
x_1	1.899***	0.114	2.093***	0.120	1.892***	0.093
x_2	2.256***	0.138	2.053***	0.118	2.142***	0.108
x_3	0.925*	0.040	0.873***	0.037	0.859***	0.033
x_4	1.145***	0.024	1.443***	0.029	1.306***	0.024
x_5	1.712***	0.054	1.574***	0.048	1.656***	0.044
x_6	4.319***	0.162	3.208***	0.121	4.187***	0.152
x_7	2.847***	0.179	3.224***	0.199	4.007***	0.277
x_8	0.834***	0.024	0.694***	0.019	0.807***	0.020
_cons	0.029***	0.001	0.027***	0.001	0.046***	0.002

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01. Robust standard error in S.E. column
Source(s): Own elaboration

We also used the Receiver Operating Characteristics (ROC), which shows all the combinations of both types of errors for different values of threshold c (the cut-off point). The area under the ROC curve for open product innovation was 0.7670, for open process innovation it was 0.7599, and for both open product and process innovation it was 0.7588. Figure 2 shows the results.

The results give grounds for further interpretation of the research results. As Table 4 shows, all three analyzed creativity-enhancing methods were statistically significant factors at a confidence level of either 0.05 or 0.01, explaining open product (y_1), open process (y_2), and open product, and process innovations (y_3). These variables were brainstorming sessions (x_1), cross-functional work groups or teams (x_2), and job rotation (x_3). For variable x_3, the value was negative. As shown in Table 5, the largest odds ratios, with increasing chances, were for cross-functional work groups or teams (x_2).

All the analyzed control variables, i.e. size (x_4), export (x_5), in-house R&D (x_6), external R&D (x_7), and industry (x8), also became statistically significant factors for all analyzed types of open innovations (y_1–y_3). However, in the case of industrial enterprises (x_8), the chances of

Table 6. Relevance table for logistic regression models

Classified	y_1 True D	~D	Total	y_2 True D	~D	Total	y_3 True D	~D	Total
+	1,289	845	2,134	1,239	786	2,025	2,924	1,455	4,379
–	6,053	40,479	46,532	6,268	40,373	46,641	7,499	36,788	44,287
Total	7,342	41,324	48,666	7,507	41,159	48,666	10,423	38,243	48,666

Classified + if predicted Pr(D) >= 0.5		True D defined as y_1 ! = 0	True D defined as y_2 ! = 0	True D defined as y_3 ! = 0
Sensitivity	Pr (+|D)	17.56%	16.50%	28.05%
Specificity	Pr (−|~D)	97.96%	98.09%	96.20%
Positive predictive value	Pr (D|+)	60.40%	61.19%	66.77%
Negative predictive value	Pr (~D|−)	86.99%	86.56%	83.07%
False + rate for true ~ D	Pr (+|~D)	2.04%	1.91%	3.80%
False − rate for true D	Pr (−|D)	82.44%	83.50%	71.95%
False + rate for classified +	Pr (~D|+)	39.60%	38.81%	33.23%
False − rate for classified -	Pr (D|−)	13.01%	13.44%	16.93%
Correctly classified		85.83%	85.51%	81.60%

Source(s): Own elaboration

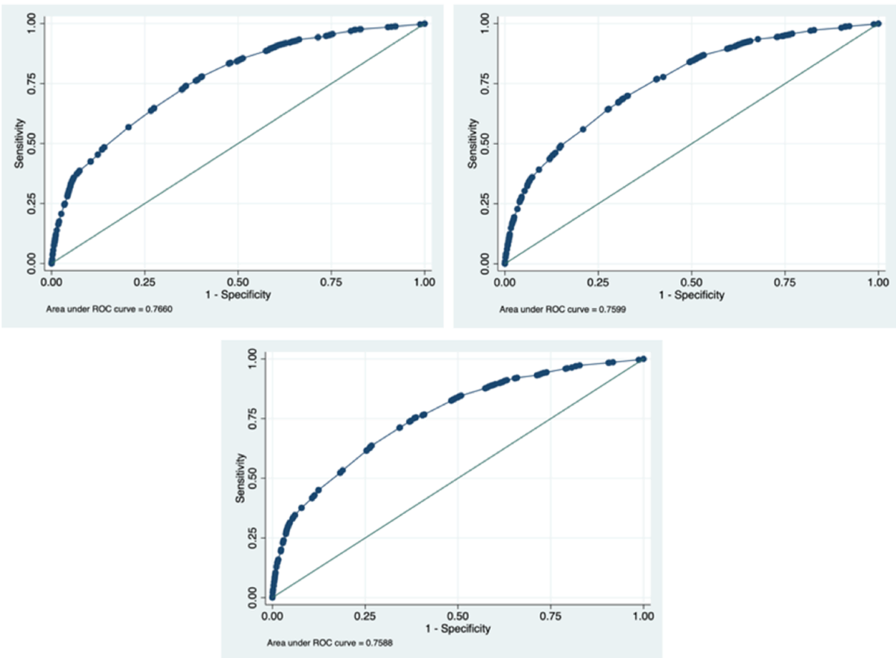

Figure 2. ROC curve for logistic regression models. Source: Own elaboration

introducing all types of open innovation were lower compared to the reference category, i.e. service enterprises.

Next, we concentrated on those enterprises that introduced both open product and process innovations. The explanatory variables with a statistically significant effect on introducing open product and process innovations at a confidence level of 0.01 were x_1, x_2, and x_3. Among them, the greatest odds ratio was for cross-functional work groups or teams (x_2) – 114.2%. In turn, job rotation (x_3) reduced the chances of introducing open innovations by 14.1%.

The above results provide only a general picture of the impact of creativity-enhancing methods on introducing open innovation. However, there is a difference resulting from the country of origin of the studied enterprises. Tables 7 and 8 show the estimation results of the separate regression models and the odds ratios for the eight analyzed EU countries. While in the case of brainstorming sessions and cross-functional work groups or teams, we did not observe any differences, in all countries, these had a statistically significant positive impact, in the case of job rotation, this method turned out to be statistically insignificant in most countries (except Romania). Moreover, in the case of Romania, it lowered the chances of introducing open product and process innovations. Regarding the control variables, we observed differences only for x_5 and x_6, which were insignificant in Estonia.

To assess the robustness of the presented results, we decided to use the bootstrap method with 1000 repetitions. This method made it possible to re-estimate the parameters and odds ratios for open product, open process, and open product and process innovation. The results (Tables 9 and 10) showed no significant differences between the data in Tables 4 and 5. We observed only slight differences in the estimation of standard errors and *p*-values. However, this did not affect the statistical significance of the evaluated variables.

Discussion and conclusions

Regarding the research question, whether the methods of stimulating creativity positively impact the implementation of open innovations, the answer is ambiguous.

The results suggest that brainstorming sessions (x_1) positively impact the implementation of all the analyzed types of open innovation. Therefore, there is no reason to reject H1 ($p \leq 0.01$). Brainstorming is based on showing employees effective ways of generating new ideas, i.e. developing ideation (Jonson, 2005). The results indicate the impact of this method on creating all forms of open innovation. Only some prior studies indicated that we could consider new ideas resulting from brainstorming as the main advantage of open innovation (Dahlander & Gann, 2010). Such studies showed this relationship in general in the context of innovation, for example, Liao and Tsai (2019), and Revilla and Rodríguez-Prado (2018). Notably, based on RBV, the results confirm one of Epstein *et al.*'s (2013) conclusions, indicating that, as a skill, brainstorming is among the critical managerial qualities. Interestingly, these results contradict the conclusions of Hofstetter *et al.* (2021), which suggested that knowledge of many competing ideas, in the case of studying open competition participants, may harm rather than stimulate creative activity, i.e. the emergence of innovations.

Nevertheless, we must recognize that the open innovation model, while widely promoted, is not without limitations. In particular, the applicability of this paradigm to SMEs or firms operating in culturally and institutionally diverse environments may be constrained. Moreover, SMEs often lack the absorptive capacity, financial resources, or formalized R&D structures to fully benefit from external knowledge flows, which may limit the effectiveness of open innovation in practice (West & Bogers, 2014; Dyduch *et al.*, 2021). Moreover, institutional factors such as regulatory frameworks, trust in external partners, and cultural attitudes toward knowledge sharing can significantly influence outcomes (Chesbrough, 2003; von Hippel, 2005). Thus, a more critical stance highlights that open innovation may not serve as a universal solution, but rather as a model whose value is contingent on contextual factors.

Table 7. Logistic regression for both open product and process innovation in selected EU countries

Variables	Bulgaria β	Croatia β	Estonia β	Greece β	Hungary β	Lithuania β	Portugal β	Romania β
x_1	0.495^{***}	0.822^{***}	0.957^{***}	0.707^{***}	0.741^{***}	0.902^{***}	0.477^{***}	0.910^{***}
x_2	0.959^{***}	0.587^{***}	0.706^{***}	0.605^{***}	0.553^{***}	0.431^{**}	0.910^{***}	0.814^{***}
x_3	-0.067	0.113	-0.232	0.018	0.008	-0.069	-0.023	-0.334^{*}
x_4	0.536^{***}	0.446^{***}	0.341^{**}	0.345^{***}	0.347^{***}	0.642^{***}	0.384^{***}	0.315^{***}
x_5	0.552^{***}	0.267^{***}	0.246	0.140^{*}	0.540^{***}	0.183^{*}	0.402^{***}	0.818^{***}
x_6	2.021^{***}	0.857^{***}	0.076	0.876^{***}	1.557^{***}	0.698^{***}	1.348^{***}	2.061^{***}
x_7	2.542^{***}	1.516^{***}	1.024^{***}	1.333^{***}	0.971^{***}	0.644^{***}	1.554^{***}	0.984^{*}
x_8	0.170^{***}	-0.285^{***}	-0.097	-0.372^{***}	-0.375^{***}	-0.431^{***}	-0.245^{***}	-0.172^{*}
_const	-3.620^{***}	-2.771^{***}	-2.265^{***}	-2.386^{***}	-3.406^{***}	-2.738^{***}	-3.376^{***}	-4.723^{***}
Log-likelihood	−5695.438	−1503.937	−626.8588	−2329.789	−3050.900	−1346.267	−3843.949	−1855.681
Wald χ^2 (8)	1914.77	352.37	101.62	402.77	986.03	291.49	1088.86	407.50
Prob > χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2 McFadden	0.1904	0.1351	0.0957	0.1028	0.1700	0.1216	0.1719	0.1152
Pseudo R^2 Nagelkerke	0.2660	0.2220	0.1640	0.1730	0.247	0.2000	0.261	0.145
Number of obs	15,495	2,651	1,019	3,942	7,337	2,380	8,224	7,578

Note(s): * p-value ≤ 0.1, ** p-value ≤ 0.05, *** p-value ≤ 0.01

Source(s): Own elaboration

Table 8. Odds ratios for both open product and process innovation in selected EU countries

Variables	Bulgaria β	Croatia β	Estonia β	Greece β	Hungary β	Lithuania β	Portugal β	Romania β
x_1	1.640***	2.276***	2.603***	2.028***	2.099***	2.465***	1.612***	2.484***
x_2	2.609***	1.798***	2.026***	1.832***	1.738***	1.539**	2.483***	2.257***
x_3	0.935	1.120	0.793	1.019	1.008	0.933	0.977	0.716*
x_4	1.708***	1.563***	1.407**	1.412***	1.414***	1.900***	1.468***	1.370***
x_5	1.737***	1.307***	1.279	1.150*	1.716***	1.201*	1.496***	2.267***
x_6	7.549***	2.356***	1.079	2.401***	4.747***	2.010***	3.852***	7.857***
x_7	12.702***	4.556***	2.784***	3.792***	2.641***	1.904***	4.732***	2.675*
x_8	1.186***	0.752***	0.908	0.689***	0.688***	0.650***	0.783***	0.842*
_const	0.027***	0.063***	0.104***	0.092***	0.033***	0.065***	0.034***	0.009***

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01

Table 9. Logistic regression with bootstrap replications for open product, open process, and open product and process innovation

Variables	y_1 Observed coef	Bootstrap S.E.	y_2 Observed coef	Bootstrap S.E.	y_3 Observed coef	Bootstrap S.E.
x_1	0.642***	0.061	0.738***	0.057	0.638***	0.050
x_2	0.814***	0.063	0.719***	0.056	0.762***	0.050
x_3	−0.078*	0.042	−0.136***	0.040	−0.152***	0.038
x_4	0.135***	0.021	0.367***	0.021	0.267***	0.019
x_5	0.538***	0.030	0.454***	0.030	0.504***	0.026
x_6	1.463***	0.038	1.166***	0.039	1.432***	0.037
x_7	1.046***	0.063	1.171***	0.062	1.388***	0.067
x_8	−0.182***	0.028	−0.365***	0.028	−0.215***	0.025
_cons	−3.531***	0.047	−3.616***	0.047	−3.088***	0.040
Replications	1,000		1,000		1,000	
Log pseudolikelihood	−17429.153		−17867.43		−21314.129	
Wald χ^2 (8)	5411.19		4610.44		5569.84	
Prob > χ^2	0.0000		0.0000		0.0000	
Pseudo R^2 McFadden	0.1557		0.1462		0.1568	
Pseudo R^2 Nagelkerke	0.2160		0.2050		0.2330	

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01
Source(s): Own elaboration

One can also assume that the positive impact of brainstorming sessions on the implementation of open innovation results from several reasons. Firstly, brainstorming encourages participants from various backgrounds, departments, and skill sets to come together and share their ideas, creating diverse perspectives. This diversity of perspectives can be crucial in open innovation, where external collaborators often bring different viewpoints and expertise. Brainstorming sessions can mimic this diversity, helping generate many innovative ideas.

Simultaneously, brainstorming represents only one among many possible techniques of collective ideation. Alternative models, such as design thinking workshops, crowdsourcing platforms, or structured approaches like the Delphi technique, may provide different dynamics and outcomes in terms of creativity and innovation (Brown, 2008; Howe, 2009; Boudreau & Lakhani, 2013). For instance, design thinking emphasizes iterative prototyping and empathy with users, which may help firms generate more user-oriented solutions. In turn,

Table 10. Odds ratios with bootstrap replications for open product, open process, and open product and process innovation

Variables	y_1 Observed OR	Bootstrap S.E.	y_2 Observed OR	Bootstrap S.E.	y_3 Observed OR	Bootstrap S.E.
x_1	1.899***	0.112	2.093***	0.119	1.892***	0.095
x_2	2.256***	0.133	2.053***	0.115	2.142***	0.103
x_3	0.925*	0.038	0.873***	0.036	0.859***	0.033
x_4	1.145***	0.024	1.443***	0.028	1.306***	0.025
x_5	1.712***	0.055	1.574***	0.048	1.656***	0.045
x_6	4.319***	0.155	3.208***	0.116	4.187***	0.152
x_7	2.847***	0.174	3.224***	0.193	4.007***	0.280
x_8	0.834***	0.024	0.694***	0.020	0.807***	0.020
_cons	0.029***	0.001	0.027***	0.001	0.046***	0.002

Note(s): * p-value ≤0.1, ** p-value ≤0.05, *** p-value ≤0.01

Source(s): Own elaboration

crowdsourcing allows organizations to tap into the knowledge of distributed communities, extending ideation beyond organizational boundaries. Therefore, future research might compare the relative benefits and limitations of these diverse models, especially in the context of open innovation.

Second, brainstorming can lead to cross-pollination of ideas. Remembering that open innovation aims to bring in external knowledge and ideas to complement internal efforts, brainstorming sessions can serve as a platform for employees to share and cross-pollinate ideas, potentially leading to creative solutions that blend internal and external insights.

Third, brainstorming is specifically designed to facilitate idea generation. Applied to the open innovation context, it can help identify new opportunities, potential partners, and innovative approaches to problem-solving or pursuing opportunities in collaboration with external entities.

Fourth, brainstorming sessions often employ techniques and exercises that encourage creative thinking, such as "thinking outside the box" or using divergent thinking strategies. These methods can stimulate participants to generate unconventional ideas, which can be particularly valuable in open innovation, where one often seeks innovative solutions.

Another finding indicates that cross-functional teams positively influence the creation of all types of analyzed open innovations, providing no reason to reject H2 ($p \leq 0.01$). Revilla and Rodríguez-Prado (2018) suggest that this method stimulates convergent thinking and the ability to discuss conflicting ideas, contributing to idea implementation. This result confirms previous research (Bunduchi, 2009) on the positive impact of multidisciplinary or cross-functional teams on stimulating innovation. It also seems to suggest that cross-functional work groups or teams lead to increased creativity in solving problems (Griffin, 1997) and greater openness in creating innovations, primarily by acquiring and generating more and more diverse information, including that related to tacit knowledge, as indicated by Söderquist's (2006) research.

The positive effect of this method of stimulating creativity may also result from several reasons. First, cross-functional work groups or teams contribute to increasing diverse expertise and perspectives. Cross-functional teams bring together individuals from various departments with unique expertise, skills and perspectives. This diversity provides a richer pool of knowledge and experiences to be drawn upon when tackling open innovation challenges, which often require a multifaceted approach.

Let us also note comprehensive problem-solving. Open innovation projects frequently involve complex challenges that require a holistic approach. Cross-functional teams are better equipped to address these challenges because they can analyze problems from different angles and consider multiple dimensions simultaneously.

Third, another factor with regard to brainstorming is the role of effective cooperation. It is important to remember that collaboration is fundamental to open innovation, and cross-functional teams are inherently designed for collaboration. Team members are accustomed to working together and leveraging each other's strengths to achieve common goals, making them more effective at engaging with external partners.

Finally, let us note the potential for faster decision-making. Cross-functional teams often make decisions more efficiently because they can quickly access the expertise needed to evaluate options and make informed choices. In open innovation, swift decision-making is crucial for capitalizing on external opportunities.

The third conclusion from the research is that staff job rotation (x_3) negatively impacts the implementation of all types of open innovation. Thus, there is a reason to reject hypothesis H_3. This result is quite surprising. It contradicts previous studies, e.g. Lundvall and Nielsen (2007), who indicated that job rotation could contribute to increasing innovativeness, and Engelsberger *et al.* (2022), who suggested that job rotation can support the efficiency of open innovation.

It is worth considering what could be the reason for this result. While staff job rotation can be a valuable tool for fostering creativity and enhancing employee skills, it can potentially hurt the implementation of open innovations in certain situations.

First, staff job rotation can lead to a loss of expertise, as frequent moves between roles limit the development of deep, specialized knowledge. Since open innovation relies on such expertise, especially in collaboration with external experts, a lack of subject matter specialists can hinder effective participation in these initiatives.

Second, staff job rotation can also reduce continuity in ongoing projects. Open innovation often demands long-term commitment, and frequent role changes may disrupt progress. Employees switching roles might not continue previous work, causing delays or even project abandonment.

Third, there is the possibility of a lack of accountability. In open innovation collaboration, it is essential to have individuals or teams responsible for driving the project to completion. When employees rotate through different roles, it can be challenging to establish clear accountability for open innovation initiatives. This lack of ownership can hinder progress and result in the project falling by the wayside.

Again, communication also plays a crucial role. With job rotation, challenges may arise as rotating staff often lack established relationships with external partners. This can hinder trust-building and effective communication, both of which are essential for successful and sustained open innovation collaborations.

Finally, we should also point out the potential impact of cultural challenges. Different departments and organizational roles may have varying attitudes and cultures regarding risk-taking and openness to external ideas. Frequent job rotation can result in employees carrying the culture of their previous roles to new positions, which may not align with the principles of open innovation.

We may also better understand the mixed effects of job rotation through the lens of organizational ambidexterity. Firms must balance exploration, searching for new knowledge and opportunities, with exploitation, refining and applying existing competencies. While job rotation may foster exploration by exposing employees to diverse roles, it may simultaneously undermine exploitation by weakening accumulated expertise and continuity. This ambidextrous tension helps explain why rotation might be beneficial for creativity in some contexts but detrimental for the sustained implementation of open innovation (Tushman & O'Reilly, 1996; Revilla & Rodríguez-Prado, 2018). Therefore, integrating insights from ambidexterity research could enrich our interpretation of the observed contradictory outcomes.

Beyond firm-level performance, we should also highlight the broader social implications of creativity-enhancing methods and open innovation. First, collaborative ideation processes can promote inclusivity by giving voice to employees across hierarchical levels and functional areas, thereby democratizing innovation practices. Second, the openness to external knowledge flows has the potential to accelerate eco-innovations and socially oriented solutions, which address pressing environmental and societal challenges (Bogers *et al.*, 2018; Liao & Tsai, 2019). Third, practices such as job rotation and cross-functional teamwork may affect employee well-being and engagement, either by enriching work experiences or, conversely, by creating stress through constant adaptation. These social outcomes deserve more systematic attention in both academic inquiry and managerial practice.

To sum up, we showed that using methods to stimulate new ideas and creativity increases the likelihood that EU companies will introduce open innovation. This leads to practical implications.

If company managers want to stimulate open innovation, they should use one of two methods to stimulate new ideas, i.e. brainstorming sessions, cross-functional work groups or teams. These contribute to implementing open innovation (in all of its forms). Regarding staff job rotation, managers should be careful when implementing open innovations.

The results also indicate future research directions.

First, it would be interesting to include techniques for stimulating creativity based on modern online technologies in future research. Undoubtedly, due to the SARS-CoV-2 pandemic, this area has developed significantly. Consequently, using artificial intelligence, machine learning, and deep learning methods is also worth considering. In particular, future studies could explore the growing role of AI-assisted ideation platforms and virtual collaboration technologies, which are becoming increasingly relevant in the context of remote work and distributed teams. These tools may fundamentally reshape how organizations stimulate and manage creativity within open innovation processes.

Second, considering the strong development of online technologies, scholars could undertake research in methods supporting creativity in the case of virtual teams working on open innovations.

Thirdly, based on the result indicating the negative impact of staff job rotation on the emergence of open innovations, research could explore its possible causes.

About the author
Salah Koubaa is also affiliated with ESCA Ecole de Management, Casablanca, Morocco.

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Corresponding author
Maciej Zastempowski can be contacted at: mz@umk.pl