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ORIGINAL ARTICLE

Motivating students to attend open innovation initiatives. A motivational structure perspective

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ABSTRACT

Given the widespread diffusion of open innovation (OI) initiatives that rely on student contributions, we aim to investigate how students' motivations for attending OI initiatives connect and interact. To this end, we conducted two studies using the laddering technique with a sample of 59 students who participated in two OI programs held in different contexts: ICARO, a business-oriented program carried out before and after the COVID-19, and TEN, a social innovation program conducted during the pandemic to help people cope with the effects of COVID-19. Our results reveal two motivational maps, illustrating commonalities and differences in motivational orientations, and highlighting core and contextual motivational structures. Our study provides evidence for the value of adopting a structural perspective on motivations and presents a comprehensive and replicable methodology for assessing motivations.

Keywords: Open innovation; Motivations; Motivational structures; Laddering; COVID-19.

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INTRODUCTION

New product development (NPD) has become increasingly complex in today's rapidly changing environment (Cocchi, Dosi, & Vignoli 2021, 2023a). In the past, NPD processes were mainly managed by a few individuals within organizations. However, the increased demand for innovation has led firms to incorporate external knowledge into their NPD processes (Antikainen, Mäkipää, & Ahonen 2010). To acquire new knowledge, organizations have started to involve customers, lead users, or communities in the NPD process, relying on their creativity and innovation capabilities (Von Hippel 2005). This phenomenon has led to more open NPD processes, and an increasing number of companies have adopted the Open Innovation (OI) paradigm (Chesbrough 2003). OI represents a shift from the traditional closed innovation paradigm to open collaboration models (Enkel, Gassmann, & Chesbrough 2009). OI is *"a distributed innovation process that involves purposely managed knowledge flows across the organizational boundary*" (Chesbrough & Bogers 2014, p. 3). OI encompasses 2 main directions of knowledge flows: outside-in and inside-out (Chesbrough 2020). In the case of outside-in knowledge flows, organizations collaborate with external stakeholders to integrate external knowledge (Gassmann & Enkel 2004). For example, Procter & Gamble established the "*Connect and Develop*" program to promote partnerships with organizations around the world (Huston & Sakkab 2006). In the case of inside-out knowledge flows, organizations allow internal ideas to flow beyond the company's boundaries, enabling others to leverage internal knowledge. For instance, Amazon offered its internal IT infrastructure to host customers' websites and IT needs (Huckman, Pisano, & Kind 2008).

The OI literature has largely focused on defining suitable business strategies for OI (Sá, Ferreira, & Jayantilal 2023). However, a successful OI strategy alone is not enough to ensure the success of an OI initiative (Bogers et al. 2017). Organizations also need to understand the motivations of the individuals involved, namely why they would participate in and contribute to an OI initiative (Antikainen, Mäkipää, & Ahonen 2010). Recent research has investigated individuals' motivations to participate in OI initiatives on web-based OI platforms (Antikainen, Mäkipää, & Ahonen 2010; Frey, Luthje, & Haag 2011; Battistella & Nonino 2012), online co-creations social media platforms (Antikainen & Niemelä 2016), government platforms (Schmidthuber, Piller, Bogers, & Hilgers 2019), and non-pecuniary initiatives (Suhada, Ford, Verreynne, & Indulska 2021). Given the widespread diffusion of OI initiatives that rely on student contributions (Cocchi, Dosi, & Vignoli 2023b), we aim to extend this body of research by investigating the motivations that drive students to voluntarily attend OI initiatives, whether initiated by firms (e.g., hackathons) or universities (e.g., OI programs). Additionally, since motivational studies tend to focus on listing and classifying individuals' motivations without considering how they might interact, we aim to shed light on a methodology that can be used to take a structural perspective on motivations.

To fill these gaps, we applied the laddering technique (Pieters, Baumgartner, & Allen 1995) and identified the motivational structure of students who wish to voluntarily attend an OI initiative.

Specifically, we studied 2 open innovation programs based on students' voluntary contributions: ICARO, managed by the Fondazione Golinelli, and TEN, handled by the University of Bologna. We selected these programs for two main reasons. First, ICARO and TEN took place in two very different contexts. The ICARO program aimed to develop solution concepts to help businesses innovate (i.e., business innovation) and took place before and after the COVID-19 pandemic, allowing in-presence participation (i.e., pre-COVID and post-COVID eras). In contrast, the TEN program aimed to develop solution concepts to address societal challenges (i.e., social innovation) and was conducted remotely during the COVID-19 pandemic (i.e., the COVID-19 era). Second, even though these OI programs differed in terms of the context of application, they still provided a suitable basis for comparison, as they shared common features such as voluntary-based participation, comparable time and effort requirements for the students, and methodology for addressing the challenges. This setting of OI programs provided a unique opportunity to compare the resulting motivational structures and to determine which remained stable across the programs, namely the core motivational orientations that are not affected by the context, and which changed, namely the motivational structures that depend on the context.

This study contributes to the OI literature by identifying the motivational orientations of students who wish to participate in OI initiatives. Our results show that proving themselves and networking are common motivational sources that are crucial to students' personal and professional development, respectively. These motivational orientations were stable across the programs, suggesting that personal and career development are the key higher-level motivations that trigger students' participation in OI initiatives. This study also provides evidence for the value of adopting a structural perspective on motivations. Indeed, our results show that common motivational sources do not necessarily lead to the same higher-level motivations. For instance, although proving themselves was linked in both studies to personal development, in the ICARO program it was due to the need to take a personal test outside the university and to fill a perceived gap in university education, whereas in the TEN program it was due to enjoying the project and feeling productive in a situation of lockdown. Finally, this study provides a comprehensive methodology that could be replicated by any organization to assess motivations.

The rest of the paper is structured as follows. In the next section, we provide the theoretical background on the motivations for participating in OI initiatives and outline the research question. In the third section, we illustrate the methodology. We then present the results of the two studies and detail the data analysis procedure used to derive them. Finally, we discuss our findings by comparing the motivational structures that emerged, highlighting their commonalities and differences.

THEORETICAL BACKGROUND

Motivations describe an individual's desire for states, incentives, or goals, both consciously and unconsciously (Winter, John, Stewart, Klohnen, & Duncan 1998). The central focus of research on OI motivations is to understand how individuals can be motivated to participate and collaborate in OI initiatives (Antikainen, Mäkipää, & Ahonen 2010). Antikainen, Mäkipää, & Ahonen (2010) have identified 9 motivational factors that prompt individuals to collaborate in OI communities, including interesting objectives and clear purpose and concept, open and constructive atmosphere, influencing and making better products/services, new viewpoints and synergy, sense of efficacy, having fun, winning competition and rewards from participation, sense of cooperation, and sense of community. Battistella & Nonino (2012) further classified motivations into intrinsic and extrinsic. They divided intrinsic motivations into individual (entrepreneurial mindset, opportunity to express individual creativity, sense of membership, and enjoyment) and social (sense of cooperation, and social responsibility), and extrinsic motivations into individual (learning, reputation, career benefits, and reciprocity), social (individual accountability, and social capital), and economic (monetary rewards, free products, and free services). More recently, Suhada, Ford, Verreynne, & Indulska (2021) investigated the relationships between motivations and identified 11 motivations for participating in OI initiatives without immediate monetary gain. They developed a temporal frame linking these motivations (Figure 1). However, as pointed out by Suhada, Ford, Verreynne, & Indulska (2021), further studies are needed to reveal how these motivations connect and interact.

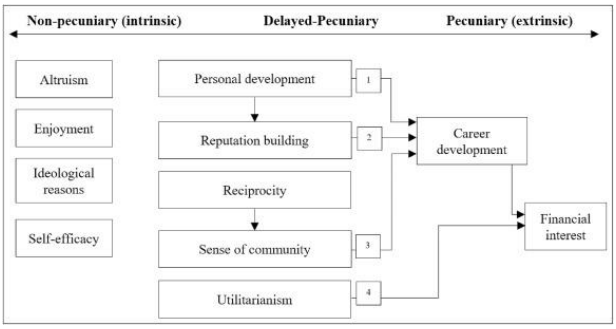

Fig. 1. Temporal framework of non-pecuniary OI motivations. Suhada, Ford, Verreynne, & Indulska (2021)

Over the past decade, both firms and universities have established a wide range of OI initiatives that rely on the voluntary participation of students. One such example is SUGAR, a global network that brings together students and companies to foster innovation through a hands-on learning experience. Leading universities around the world enable students to form multidisciplinary teams and collaborate on design challenges provided by corporate partners. Similarly, CBI (Challenge Based Innovation) is an OI program in which multidisciplinary teams of students collaborate with partner organizations to develop projects that can solve complex societal problems, inspired by technological ideas that come from research at CERN (Balboni, Dosi, Marchini, Mincolelli, & Vignoli 2021). Additionally, many firms have started to leverage hackathons and other OI methodologies to generate a wealth of creative ideas by engaging students in their programs (Mincolelli, Cocchi, Dosi, & Vignoli 2020; Taylor & Clarke 2018). Considering the plethora of OI initiatives based on students' contributions, it becomes crucial to understand the motivations that drive students to participate and make the initiatives successful.

Thus, we aim to answer the following research question: *what is the motivational structure of students who voluntarily attend OI initiatives?*

METHOD AND DATA COLLECTION

To address the research question, we collected data by relying on 2 representative OI programs (Siggelkow 2007). The main characteristics of the selected programs are reported in Table 1. We detailed in Appendix A additional information related to both programs.

Tab. 1. Characteristics of the selected OI programs

OI program	ICARO	TEN
Leading institution	Fondazione Golinelli	University of Bologna
Goal of the program	Business innovation: design desirable, viable, and feasible solutions based on challenges issued by partner companies	Social innovation: design quickly implementable solutions to assist people in dealing with the COVID-19
Era under investigation	Pre-COVID (from 2016 to 2019) and post-COVID (2021)	COVID (from March to May 2020)
Project work	In-person	Remote
Students involved	200	102
Teams	Multidisciplinary teams	Multidisciplinary teams
Effort of the program	84 hours	80 hours
Methodological approach	Design thinking	Design thinking
Economic motivation	Voluntary-based	Voluntary-based

The Fondazione Golinelli, in partnership with the Universities of Bologna, Modena and Reggio Emilia, Parma, and Ferrara, manages the ICARO program. We collected data from students who participated in the program between its first edition in 2016 and its last edition before the outbreak of the COVID-19 pandemic in 2019, and in the 2021 edition. The ICARO program facilitates connections between students and firms by having master's students work on multidisciplinary teams for a duration of 6 months, to develop solutions to design challenges posed by partner firms. The program is voluntary, meaning that students do not receive any compensation, monetary rewards, or additional credits for their participation. During the COVID-19 pandemic, the University of Bologna ran the TEN program in collaboration with the Universities of Modena and Reggio Emilia, Parma, and Ferrara, and the UNA Europa alliance of universities. The TEN program was conducted in two phases, with the regional program OPER.TEN running from March 25th to April 5th, 2020, and the European program UNA.TEN from April 27th to May 8th, 2020. A total of 102 master's students participated in the TEN program, working in multidisciplinary teams for 10 days to develop implementable solutions to address the challenges posed by COVID-19. The program engaged several partners to collaborate with students in the design of solution concepts. TEN was a voluntary program.

To collect data, we relied on the interview technique called "*laddering*" (Reynolds & Gutman 1988) since it is ideally suited to gather data that allow the modeling of goal structure. According to Pieters, Baumgartner, & Allen (1995), goals above the basic level provide the motivation for why an individual is pursuing the focal goal. The paper-and-pencil version of laddering (Walker & Olson 1991) perfectly suits such investigation. We conducted the first study with 18 students (8 females, 10 males) who participated in the ICARO program from the University of Bologna – Italy (16), and the University of Parma – Italy (2). The second study involved 41 students (21 females, 20 males) who participated in the TEN program from the University of Bologna – Italy (19), the University of Paris Panthéon-Sorbonne – France (5), the Jagiellonski University – Poland (5), the University of Ferrara – Italy (5), the KU Leuven University – Belgium (3), the Helsingin Yliopisto University – Finland (2), the Complutense University of Madrid – Spain (1), and the Politecnico di Milano – Italy (1). The research was described as a study that aimed to investigate the motivations of students to voluntarily participate in OI programs, which was specified as the focal goal. Students were asked to complete a survey through the Qualtrics platform. We asked students for their aims or reasons for attending the OI program. They could specify as many as four reasons. For each reason given, they were asked why it was important to them, and if they provided an answer, they were again asked why that reason was important (see the survey in Appendix B).

DATA ANALYSIS AND RESULTS

Given that the responses obtained were idiosyncratic, we first performed a *content analysis* and classified the collected data into a limited number of motivational categories for both studies (Reynolds & Gutman 1988). Next, we developed *the implication matrix* for both studies in which the identified categories of motivations acted as the row and the column elements (Pieters, Baumgartner, & Allen 1995). Then, to provide insights into the *position that individual motivations have in the motivational structure*, we calculated the abstractness, centrality, and prestige of the motivational categories (Knoke & Burt 1982) for both studies. Finally, to *represent the connections between motivations in a graphical form* for both studies, we considered the non-zero cells of the implication matrices and selected a cut-off level based on Reynolds & Gutman's heuristic (1988) to focus on the dominant orientations in the motivational structures. According to these steps (Figure 2), we report the results of the 2 studies below.

Study 1: ICARO

Content analysis

We assigned students' responses in the laddering to a small yet comprehensive set of motivational categories. We coded the 18 laddering protocols and grouped the responses into 14 motivational categories: (A) *working in a multidisciplinary team* (working with people that have different but complementary skills); (B) *getting in contact with companies* (approaching the world of work); (C) *word of mouth* (information collected from previous participants about the strengths and weaknesses of the program); (D) *filling a perceived university training gap* (bridging a perceived educational gap in terms of homogeneity of courses and concreteness of projects); (E) *networking* (meeting people who might be useful to know); (F) *interest in the project* (curiosity in terms of topics covered and methodology adopted); (G) *doing extracurricular activities* (doing activities that are organized outside of the regular curriculum or course); (H) *boosting experiences* (doing a broad range of activities to enhance experience); (I) *prove themselves* (test how good one is at solving problems and applying the developed skills in a working environment); (J) *personal testing outside the university boundaries* (getting feedback from the actors involved in the program to test one's professional profile); (K) *enjoying the project* (having the benefits of design process and socialization with other people); (L) *seizing extracurricular opportunities* (catching unexpected opportunities); (M) *career development* (professional growth); (N) *personal development* (developing new skills, capabilities, and potential). For purposes of analysis, we made two adjustments to students' responses. First, when a student gave two subsequent responses (in immediate succession) which were considered to belong to the same motivational category, the motivation was counted only once. Second, when a student turned back to the initial motivation after one intermediary motivation, the last motivation was deleted. In total, the 18 students mentioned 117 motivations, for an average of about 6 motivations per student. The number of motivations mentioned ranged between 2 to 10. Personal development was mentioned most often (n=25), with career development (n=19) placed second, filling a perceived university training gap (n=12) placed third. Enjoying the project (n=2), and personal testing outside the university boundaries (n=3) were mentioned least often.

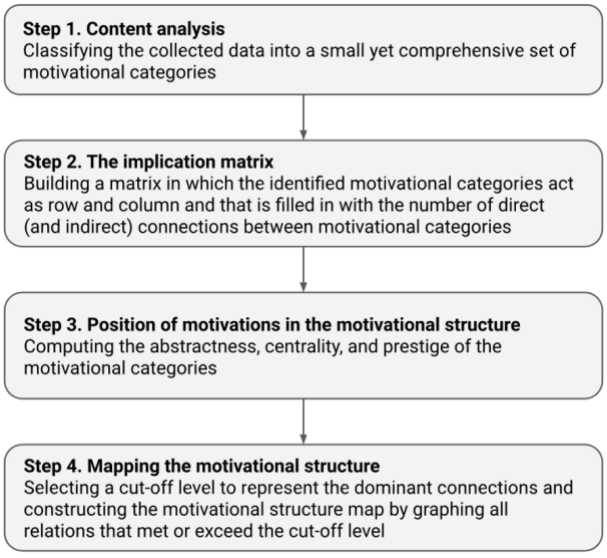

Fig. 2. Data analysis procedure

The implication matrix

Each cell of the implication matrix related to ICARO (see Table A in Appendix A) contains the frequency that a particular row motivation is followed by a particular column motivation, aggregated across students and ladders. The cells of the implication matrix related to ICARO contain the number of direct connections between motivations (i.e., when one motivation is mentioned directly after another motivation in the same ladder) outside brackets, and the number of direct plus indirect connections (i.e., when the two motivations are mentioned in the same ladder but separated by one intermediary motivation) between motivations inside brackets. Since data in Table A show that direct connections accounted for the majority of all (direct plus indirect) connections among motivations (89 percent), all subsequent analyses were conducted for direct connections only.

Position of motivations in the motivational structure

Table B (see Appendix A) reports the abstractness (computed as the ratio of in-degrees over in-degrees plus out-degrees of the motivation), centrality (computed as the ratio of in-degrees plus out-degrees of a particular

motivation over the sum of all the 256 cell entries of the implication matrix related to ICARO), and prestige (computed as the ratio of in-degrees of a particular motivation over the sum of all the 256 cell entries of the implication matrix related to ICARO) of the motivations. The most concrete motivations are working in a multidisciplinary team (abstractness = 0,00), word of mouth (abstractness = 0,00), networking (abstractness = 0,00), doing extracurricular activities (abstractness = 0,00), and prove themselves (abstractness = 0,00), which suggest that they are the main motivational source. On the contrary, the most abstract motivations are filling a perceived university training gap (abstractness = 1,00), and career development (abstractness = 1,00), which suggest that they are the main motivational destination. Inspection of Table B shows that filling a perceived university training gap (centrality = 0,05) and personal development (=0,05) are the most central motivations in the motivational structure, followed by career development (centrality = 0,04). Finally, Table B shows that in this motivational structure, filling a perceived university training gap has the highest prestige score (prestige = 0,05), followed by career development (prestige = 0,04), and personal development (prestige = 0,04). Correlations between the three indices are reported at the bottom of Table B.

Mapping the motivational structure

To represent the dominant connections between motivations in a graphical form and display the motivational map, we chose a cut-off level based on Reynolds & Gutman's heuristic (1988) that suggests comparing the proportion of active cells in the implication matrix (columns 2 and 3 in Table C) to the proportion of all connections between motivations accounted for at a given cut-off level (column 5 in Table C). The information necessary to make this decision is presented in Table C (see Appendix A). A cut-off level of 2 was deemed most appropriate in this case. Indeed, in close agreement with the rule of thumb given by Reynold & Gutman (1988), at this cut-off level, we can account for 60 percent of all connections between motivations made by students (column 5 in Table C) using only 4 percent of all possible cells in the implication matrix (column 2 in Table C) and only 32 percent of the cells that contain a non-zero entry (column 3 in Table C). According to the cut-off level chosen, Figure 3 reports the motivational structure map related to ICARO.

The motivational structure map was constructed from the implication matrix related to ICARO by graphing all relations that met or exceeded the chosen cut-off level of 2. The motivations that did not lead to higher (or lower) level motivations were left outside of the motivational structure map. This does not mean that they are not important, but that they can still be studied as stand-alone motivations. The motivations are vertically presented in ascending order of their abstractness score. The arrowheads show the direction of the connection between motivations, and the numbers reported how often a given connection between motivations was made. The different dimensions of the circles represent the fact that different motivations were mentioned more or less frequently (the larger the circle, the more frequently the associated motivation was mentioned).

Figure 3 reveals 5 major motivational orientations of students that attended the ICARO program. ***The first orientation (i)*** involves the willingness to work in a multidisciplinary team to grow personally. Master's students that attended the ICARO program rarely had the possibility during their educational path to collaborate with peers coming from other disciplines. Even if their universities promoted project-based learning experiences within their courses, such experiences were often based on a background that was shared among all participants. As one student reported: "*During my time in university, I learned the significance of collaborating with individuals from diverse backgrounds. However, I had yet to work alongside non-designers. As a result, I actively sought out an opportunity to engage with individuals from different fields.*" [working in a multidisciplinary team]. Specifically, students were looking for a multidisciplinary program to support their personal development. As one of them said: "*I aspired to acquire knowledge of alternative methodologies and approaches that differ from those related to my academic training. I wanted to learn how to collaborate with individuals who possessed a distinct mindset from my own*" [personal development]. ***A second orientation (ii)*** reflects the soliciting role of word of mouth that, through feedback from students who attended the program previously, triggers other students who see the program as an opportunity to learn and improve. Master's students that attended the ICARO program were sensitive to what was going on around them and were constantly looking for enticing experiences. In that context, word of mouth mattered. As one student stated: "*I talked with […] about his ICARO experience. He was enthusiastic about the whole initiative"* [word of mouth]. She then added: *"I thought it was the right experience for me to grow*" [personal development]. ***A third orientation (iii)*** concerns the willingness of students to prove themselves to get additional individual learnings, to obtain feedback from the actors involved in the program and experiment with their professional profile, and to fill a perceived university training gap. Master's students that attended the ICARO program wanted to prove themselves. As one of them stated: "*I desired a down-to-earth experience to challenge myself, step out of my comfort zone, and take on new and potentially unfamiliar situations*" [prove themselves]. These students were looking for such a challenge because they wanted to "*learn and acquire new skills*" [personal development], test their professional profiles *"with someone working in the field*" [personal testing outside the university boundaries], and test whether they can solve real problems "*because the university is too abstract and not connected with the real*

world" [filling a perceived university training gap]. ***A fourth orientation (iv)*** relates to the student's desire of experiencing extracurricular activities to bridge a perceived university training gap. Master's students that attended the ICARO program were motivated to engage in extracurricular activities to explore novel experiences outside the scope of their academic curriculum. As one student reported: "*I wanted to try something different from the university, to engage in some activities that were not covered by the university curriculum*" [doing extracurricular activities]. Specifically, they wanted to gain additional experience and knowledge that was not offered in their courses. As one student explained: "*I looked for activities that could have offered me with different perspectives than those I was constantly exposed to in classes*" [filling a perceived university training gap]. Finally, ***a fifth orientation (v)*** expresses the importance of building a network of relationships to build a career. Students that attended ICARO wanted to "*meet new people and make relevant connections*" [network] or "*get a foot in the business world by establishing connections with companies*" [getting in contact with companies] to *"leverage these connections later on to improve the career*" [career development].

Study 2: TEN

Content analysis

We assigned students' responses to a set of motivational categories. We coded the 41 laddering protocols and grouped the responses into 14 motivational categories: (A) *doing something helpful during the lockdown* (engaging in something that could have been useful to face the pandemic); (B) *feeling better during the lockdown* (feeling healthy, relaxed, and full of energy again after a period of loneliness, depression, boredom, fears, and anxieties); (C) *feeling productive during the lockdown* (engaging in something to create a new daily routine and avoid being passive, worrying about not being productive enough while staying home, and feeling guilty about bad habits); (D) *sense of community* (feeling of belonging and contributing to society); (E) *networking* (meeting people who might be useful to know); (F) *interest in the project* (curiosity in terms of challenges tackled and methodology adopted); (G) *doing extracurricular activities* (doing activities that are organized outside of the regular curriculum or course); (H) *boosting experiences* (doing a broad range of activities to enhance experience); (I) *prove themselves* (test how good one is at solving problems and applying the developed skills in an international working environment); (J) *influencing and making better products/services* (developing solutions and creating a positive impact on society); (K) *enjoying the project* (having the benefits of design process and socialization with other people); (L) *generate novel solutions for novel problems* (generating implementable solutions to solve a difficult situation); (M) *career development* (professional growth); (N) *personal development* (developing new skills, capabilities, and potential). We made three adjustments to students' responses. First, when a student gave two subsequent responses which were considered to belong to the same motivational category, the motivation was counted only once. Second, when a student turned back to the initial motivation after one intermediary motivation, the last motivation was deleted. Third, when a student gave two (or more) responses to the same question which were judged to belong to the same motivational category, the motivation was counted only once. In total, the 41 students mentioned 212 motivations, for an average of about 5 motivations per student. The number of motivations mentioned ranged between 2 to 8. Personal development was mentioned most often (n=30), with networking (n=26) placed second, doing something helpful during the lockdown (n=25) placed third, interest in the project (n=23) placed fourth, and career development (n=21) placed fifth. Generate novel solutions for novel problems (n=2) and doing extracurricular activities (n=3) were mentioned least often.

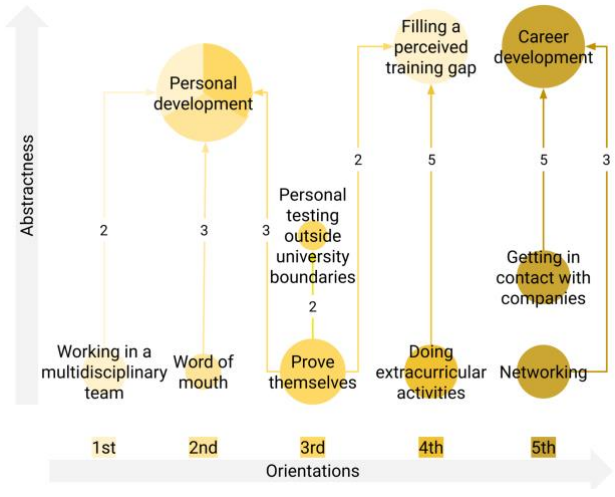

Fig. 3. Motivational structure map related to ICARO

The implication matrix

Each cell of the implication matrix related to TEN (see Table D in Appendix A) contains the frequency that a particular row motivation is followed by a particular column motivation, aggregated across students and ladders. The cells of the implication matrix related to TEN contain the number of direct connections between motivations outside brackets, and the number of direct plus indirect connections between motivations inside brackets. Since data in Table D show that direct connections accounted for most of all connections among motivations (89 percent), all subsequent analyses were conducted for direct connections only.

Position of motivations in the motivational structure

Table E reports the abstractness, centrality, and prestige of the motivations. The most concrete motivations, in this case, are networking (abstractness =

0,10), doing something helpful during the lockdown (abstractness = 0,17), and interest in the project (abstractness = 0,19), which suggest that they are the main motivational source, while the most abstract motivations are feeling better during the lockdown (abstractness = 0,92), and sense of community (abstractness = 1), which suggest that they are the main motivational destination. Table E also shows that personal development is the most central motivation (centrality = 0,08) in the motivational structure, followed by doing something helpful during the lockdown (centrality = 0,07), interest in the project (centrality = 0,062), and feeling productive during the lockdown (centrality = 0,058). Lastly, Table E shows that in this motivational structure, personal development has the highest prestige score (prestige = 0,06), followed by feeling better during the lockdown (prestige = 0,04), and career development (prestige = 0,04). Correlations between the indices are shown at the bottom of Table E.

Mapping the motivational structure

To represent the dominant connections between motivations in a graphical form and display the motivational map, we chose a cut-off level based on Reynolds & Gutman's heuristic (1988). A cut-off level of 2 was considered most appropriate in this case. Indeed, at this cut-off level, we can account for 68 percent of all connections between motivations made by students (column 5 in Table F) using only 8 percent of all possible cells in the implication matrix (column 2 in Table F) and only 38 percent of the cells that contain a non-zero entry (column 3 in Table F). Figure 4 reports the motivational structure map related to TEN. It was constructed from the implication matrix related to TEN by graphing all relations that met or exceeded the selected cut-off level in ascending order of their abstractness score.

Figure 4 reveals 4 major motivational orientations of students that attended TEN. ***The first orientation (i)*** involves the willingness to do something helpful during the pandemic to feel productive during the lockdown (e.g., "*I wanted to do something academic, as we had no courses at that moment*"), better during the lockdown (e.g., "*I felt lonely, depressed, bored, scared, useless and without social interactions*"), part of and contribute to society (e.g., "*I desired to be a part of a movement that involved nurses, doctors, and volunteers, who demonstrated extraordinary efforts in assisting people*"). ***A second orientation (ii)*** reflects the willingness of students to prove themselves to feel productive, enjoy the creative dimension of the project, and get individual learning. Master's students that attended TEN wanted to prove themselves. As one of them reported: "*I wanted to challenge myself above all, test my skills and knowledge in a novel situation*". Students were looking for such a challenge to feel productive during the lockdown (e.g., "*The program was conducted during a period of complete lockdown. My primary objective was to overcome the pervasive feelings of helplessness and boredom and get back on track. When I became aware of the opportunity to develop a solution that could benefit society at large, I felt compelled to accept*", to carry out a project they were excited about (e.g., "*I was aware that such an ambitious project would have stimulated my interest*", and to grow as individuals "*would have provided me with substantial learning opportunities*". ***A third orientation (iii)*** concerns the interest of students in the project in order both to influence and make better products and services and to grow personally and professionally. Students that attended TEN were motivated by an intrinsic interest in the project in terms of the methodology adopted and challenges tackled. As one of them explained: "*I was highly curious about the challenges at hand, finding them immensely appealing. I was eager to apply the design thinking methodology to address such societal challenges*". This interest is rooted in the desire of influencing and making better products and services (e.g., "*As a student, it is a rare opportunity to witness the realization of one's projects. Considering the partnerships with organizations in this OI program, I envisioned the potential realization of the project: the development of a real solution*"), personal growth (e.g., "*I wanted to understand how to apply the methodology for social innovation*"), and career advancements (e.g., "*I wanted to boost my CV*"). Finally, ***a fourth orientation (iv)*** expresses the importance of building a network of relationships (e.g., "*I wanted to meet new people and boost my network*") to grow both as an individual (e.g., "*I like to learn from new people*") and as a professional (e.g., "*I was looking for new collaborations*").

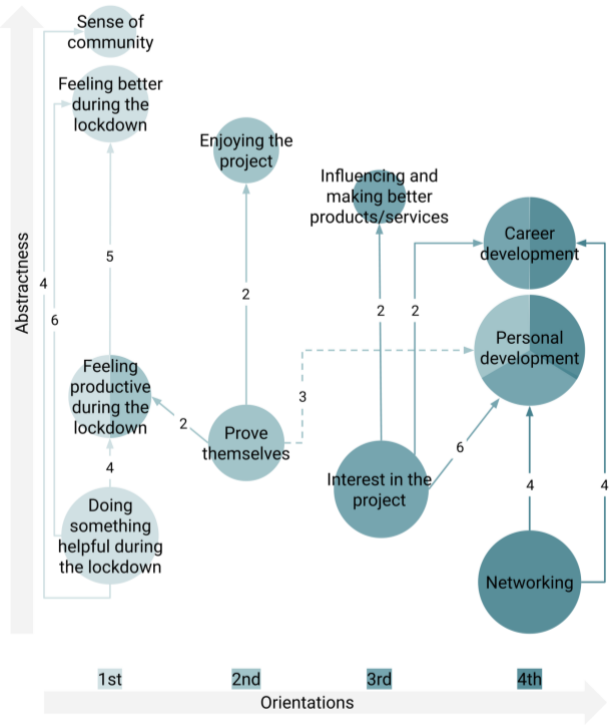

Fig. 4. Motivational structure map related to TEN

DISCUSSIONS AND CONCLUSIONS

Results reveal commonalities and differences between the motivational structures of students who voluntarily attend OI initiatives in different contexts.

Core motivational structures (aka what is stable)

A comparison of Figures 3 and 4 reveals that proving themselves and networking are common motivational sources among students and that personal and career development are common higher-level motivations driving students' participation in OI initiatives. Specifically, when comparing Figures 3 and 4, it becomes apparent that students want to prove themselves and build a network of relationships, respectively, to grow personally and professionally (Table 2). These motivational orientations remained stable across the programs. These motivational orientations are consistent with prior research, which has shown that individuals seek to prove themselves to gain knowledge about how to perform better (Mills 1991), and that networking plays a crucial role in career development (Kuijpers & Scheerens 2006). These core motivational structures extend the current literature on OI motivations to students and show that students ultimately seek to build their personal and professional futures. This finding is consistent with the temporal framework of non-pecuniary OI motivations developed by Suhada, Ford, Verreynne, & Indulska (2021) but highlights that students do not necessarily seek personal growth solely to establish a better career trajectory. Master's students are nearing the end of their university careers, and they have developed competencies that have yet to be tested in the real world. Our findings suggest that students want to start using their competencies in the real world, and OI initiatives provide a good starting point for them if they perceive a safe and comfortable environment in which they can learn, grow, and connect with other people (Urdan & Schoenfelder 2006).

Common motivations do not necessarily imply common motivational structures

Although proving themselves links to personal development in both studies, it is worth noting that proving themselves is also motivated by other end motivations. Whereas in the case of the ICARO program proving themselves is due to the need of conducting a personal test outside of the university's boundaries and filling a perceived university training gap, in the case of TEN proving themselves is due to enjoying the project and feeling productive in a situation of lockdown (Table 3). The same logic applies to networking. Although in both studies networking is linked to career development, the results show that, in the case of TEN, networking is also motivated by personal development (Table 3). These findings demonstrate the value of taking a structural perspective on motivations, as the same motivational sources might have different purposes. Our results suggest that although students in both contexts have similar aspirations for their future (i.e., the core motivational structures), they approach their future differently depending on the current situation. Whereas in a business-driven and stable context students want to challenge themselves to test their current job profile and fill a perceived training gap, in a social innovation and emergency context students challenge themselves to feel productive and enjoy the project. Additionally, in the latter case, students also value connecting with others to grow as individuals.

Tab. 2. Common motivational structures

Motivational sources	Higher-level motivations (ICARO)	Higher-level motivations (TEN)
Prove themselves	*Personal development*	*Personal development*
Networking	*Career development*	*Career development*

Tab. 3. Common motivational sources that lead to different higher-level motivations

Motivational sources	Higher-level motivations (ICARO)	Higher-level motivations (TEN)
Prove themselves	*Personal testing outside the university boundaries*	*Enjoying the project*
	Filling a perceived university training gap	*Feeling productive during the lockdown*
Networking	-	*Personal development*

Context-depended motivational structures (aka what changes)

A comparison of Figures 3 and 4 shows that several motivational structures are context-specific (Table 4).

Tab. 4. Context-dependent motivational structures

Motivational sources	Higher-level motivations (ICARO)	Higher-level motivations (TEN)
Working in a multidisciplinary team	*Personal development*	-
Word of mouth	*Personal development*	-
Doing extracurricular activities	*Filling a perceived university training gap*	-
Doing something helpful during the lockdown	-	*Feeling productive during the lockdown*
		Feeling better during the lockdown
		Sense of community
Interest in the project	-	*Influencing and making better products/services*
		Personal development
		Career development

Therefore, organizations seeking to promote OI initiatives based on voluntary student participation need to consider contextual factors and design interventions to enhance students' motivations accordingly. Our findings suggest that, within a stable and business-oriented OI context, students are motivated by working in a multidisciplinary team for personal growth. This orientation suggests that students recognize the value of working in teams with people from different backgrounds and are interested in engaging with others to broaden their perspectives. Therefore, organizations promoting OI initiatives in such contexts should emphasize the multidisciplinary aspect of the initiative to attract students. Furthermore, our results show that students in this context relate word of mouth to their personal development and associate positive (negative) word of mouth with a good (bad) opportunity to grow. Hence, organizations promoting OI initiatives should be aware of this motivational structure and consider that word of mouth will also affects future participation in the initiative, as students are more likely to be interested in the initiative if they have heard good things about it from someone they trust. Lastly, the results suggest that students seek additional experience and knowledge beyond what is offered in their university courses and are interested in activities that provide them with different perspectives. This motivational structure partly explains many of the efforts made by universities, including the design of OI programs, which aim to bridge the gap and create links between students and firms. In contrast, our study reveals that in a social innovation and emergency context, students are motivated by doing something helpful to feel productive, better, and contribute to society. This motivational orientation was largely due to the emergency circumstances surrounding TEN, which was conducted in the middle of the pandemic, and underscores students' sensitivity and responsiveness to societal challenges. Furthermore, our results show that in such a context, students were motivated by an intrinsic interest in the project in terms of the methodology used and the challenges addressed. This interest is rooted in the desire to influence and create better products and services, as well as personal and professional growth.

Implications, limitations, and future research

Traditionally, OI research has adopted a firm-centric perspective (Bogers et al. 2017) by focusing on the private benefits of innovation (Chesbrough & Bogers 2014). However, in recent years there has been a shift towards a societal perspective on OI, with an emphasis on non-profit organizations such as NGOs, government agencies, universities, and research centers (Chesbrough, West, & Vanhaverbeke 2014; Bogers et al. 2017; Dosi, Cocchi, & Vignoli 2021). The TEN and ICARO programs are examples of the latter OI initiatives, which aim to address complex societal challenges (Enkel, Gassmann, & Chesbrough 2009) through multidisciplinary collaborations between students, researchers, and business professionals (Perkmann et al. 2013). Although our data relate to university-led OI initiatives, our motivational maps can also be considered by private firms that launch OI initiatives based on student volunteer contributions, such as hackathons (Lifshitz-Assaf, Lebovitz, & Zalmanson 2021).

A key takeaway for universities and firms is that simply having a well-planned OI initiative in terms of the innovation process does not guarantee its success (Bogers et al. 2017). In fact, this study shows that organizations need to consider the context in which the OI initiative is implemented and develop a motivational system that is tailored to the individuals involved. Without knowing people's motivations, decision makers would not consider an essential driver of success and would design changes to an initiative based solely on their feelings or the feedback they receive. With this study, we have provided a methodology that allows for a more holistic view of evaluating OI and facilitates the design of experiments around OI initiatives.

Most importantly, this research provides a comprehensive methodology for taking a structural perspective on motivations that universities and firms can replicate to evaluate their OI initiatives. These organizations can conduct similar studies in their OI programs by using - or possibly adapting - the survey developed (Appendix B) and conducting the analysis following the steps shown in Figure 1 (and detailed in the data analysis and results section) to assess the motivational structures of the individuals involved. Such assessments can help to improve the attractiveness and performance of their OI initiatives.

It is worth noting that this methodology can be extended to identify motivations beyond OI initiatives. For example, it could be used to identify the motivations of individuals who express an interest in participating in experimental activities to understand what their key drivers are for participation, and thus improve recruitment strategies and the design of engaging experimental opportunities.

The results of this research should be read considering their limitations, which also suggest avenues for future research. First, given that our maps of motivational structures are based on a sample of 59 students, we recognize that the list of motivations may not be exhaustive. In this regard, future studies could explore other motivational orientations. Second, further studies could extend our motivational structure maps in other contexts to improve and complement our findings.

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APPENDIX A: ICARO, TEN, AND DATA ANALYSIS RESULTS

ICARO[1] is a complementary training OI program aimed at developing personal growth and bridging the gap between study and working life. Interaction with companies allows students to begin to understand business logic and approach the real world. The experience fosters a greater awareness of the application potential of the course of study. The course, together with the collaborative comparison with other students, facilitates the focus on personal attitudes and interests. As defined on the official website, *"ICARO is an entrepreneurial gymnasium designed to bring university students closer to corporate culture and stimulate their creativity, passion, and resourcefulness*".

How it works. Participation in the project is free of charge. The teams work for 6 months, supported by the staff of Fondazione Golinelli and a group of mentors who are experts in different fields. Participants receive training and meet with teachers, professors, startuppers, and entrepreneurs. Students face real-world challenges set by leading local companies. Teams explore a variety of perspectives, from that of customers to that of collaborators and stakeholders. The didactic methodology used is that of project-based learning, which sees learning as the result of a real and personally meaningful experience. After the final event, the teams with the best potential ideas could benefit from an additional training period to further develop concrete solutions, pilot projects, and businesses.

The program. ICARO aims to provide concrete solutions to problems and challenges posed by local and national companies, with an OI perspective. The scientific direction is curated by a faculty of excellence, made up of university professors, professionals, and entrepreneurs. ICARO was conceived, created, and promoted in 2016 by Fondazione Golinelli, in collaboration with the University of Bologna. For 2020, the partnership has been extended to the University of Modena and Reggio Emilia, the University of Parma, and the University of Ferrara. This new edition follows a pioneering path for the Italian ecosystem, combining the design thinking approach with the lean startup: the former brings design around the concrete needs of people, and the latter proposes a design inspired by the scientific method of cyclical experimentation and testing of hypotheses, using available resources more efficiently.

[1] https://www.fondazionegolinelli.it/en/area-impresa/icaro

Tab. A. The implication matrix related to ICARO

MOTIVATIONS		A	B	C	D	E	F	G	H	I	J	K	L	M	N	Out-degrees of row motivations
A	*Working in a multidisciplinary team*				1(1)		1(1)		1(1)					0(1)	2(2)	5(6)
B	*Getting in contact with companies*				1(1)								1(1)	5(5)		7(7)
C	*Word of mouth*													0(1)	3(3)	3(4)
D	*Filling a perceived university training gap*															0(0)
E	*Networking*		1(1)		0(1)							1(1)	1(1)	3(3)		6(7)
F	*Interest in the project*				1(1)											1(1)
G	*Doing extracurricular activities*				5(5)											5(5)
H	*Boosting experiences*													1(1)	1(1)	2(2)
I	*Prove themselves*				1(2)		1(1)				2(2)			0(1)	3(3)	7(9)
J	*Personal testing outside the university boundaries*				2(2)											2(2)
K	*Enjoying the project*														1(1)	1(1)
L	*Seizing extracurricular opportunities*				1(1)											1(1)
M	*Career development*															0(0)
N	*Personal development*												1(1)	1(1)		2(2)
In-degrees of column motivations		0(0)	1(1)	0(0)	12(14)	0(0)	2(2)	0(0)	1(1)	0(0)	2(2)	1(1)	3(3)	10(13)	10(10)	42(47)

Tab. B. Information about the position of motivations in the ICARO motivational structure and correlations among indices

	MOTIVATIONS	ABSTRACTNESS	CENTRALITY	PRESTIGE
A	*Working in a multidisciplinary team*	0,00	0,02	0,00
B	*Getting in contact with companies*	0,13	0,03	0,00
C	*Word of mouth*	0,00	0,01	0,00
D	*Filling a perceived university training gap*	1,00	0,05	0,05
E	*Networking*	0,00	0,02	0,00
F	*Interest in the project*	0,67	0,01	0,01
G	*Doing extracurricular activities*	0,00	0,02	0,00
H	*Boosting experiences*	0,33	0,01	0,00
I	*Prove themselves*	0,00	0,03	0,00
J	*Personal testing outside the university boundaries*	0,50	0,02	0,01
K	*Enjoying the project*	0,50	0,01	0,00
L	*Seizing extracurricular opportunities*	0,75	0,02	0,01
M	*Career development*	1,00	0,04	0,04
N	*Personal development*	0,83	0,05	0,04
ABSTRACTNESS		1,00		
CENTRALITY		0,45	1,00	
PRESTIGE		0,86	0,81	1,00

Tab. C. Statistics for determining a cut-off level for ICARO

Cut-off	(1) Number of active cells	(2) Number of active cells as a proportion of all possible (non-diagonal) cells	(3) Number of active cells as a proportion of all cells mentioned at least once	(4) Number of active linkages	(5) Number of active linkages as a proportion of all linkages
1	25	0,14	1,00	42	1,00
2	**8**	**0,04**	**0,32**	**25**	**0,60**
3	5	0,03	0,20	19	0,45
4	2	0,01	0,08	10	0,24
5	2	0,01	0,08	10	0,24

TEN[2] was an OI program that aimed to design quickly implementable solutions to help people cope with the pandemic and to develop the personal growth of students in a context where they felt alone and without too much to do. The University of Bologna designed TEN in two iterations. The first iteration, carried out during the first phase of the emergency (from March 25th to April 5th, 2020), generated OPER.TEN, an OI program involving 20 master's students from the universities of Bologna, Modena and Reggio Emilia, and Ferrara. The second iteration generated UNA.TEN, an OI program conducted during the second phase of the emergency (from April 27th to May 8th, 2020) that involved 82 master's students from the Bologna, Ferrara, Politecnico di Milano, Paris Panthéon-Sorbonne, Jagiellonski, KU Leuven, Helsingin Yliopisto, Complutense University, and Edinburgh Universities.
How it worked. Participation in both programs was free. Students worked for 10 days in multidisciplinary teams, supported by some professors and research fellows from the universities involved, and by a group of innovation coaches coming from the OI unit of Almacube, the incubator and innovation hub of the University of Bologna. Every day, the students were trained by professors, research fellows, innovation coaches, and employees of the participating partner companies. Their goal was to face COVID-19-related challenges by applying OI and design thinking tools, which were theoretically introduced at the beginning of each day. TEN implemented a project-based learning didactic methodology: the combination of theoretical introduction and practical application allowed the students to experience first-hand the tools and knowledge acquired, by materializing innovative ideas and making them tangible. At the end of the programs, the teams had the opportunity to benefit from an additional training period with the companies involved to refine and implement the identified solution concepts. The interaction with companies allowed students to begin to understand how to solve business and social problems and approach the real world. The program facilitated the focus of students on their attitudes and interests.
The program. TEN aimed to create concrete solutions to COVID-19 problems and challenges through open and frugal innovation. The scientific direction was curated by professors and research fellows of the University of Bologna. TEN was conceived, created, and promoted by the University of Bologna, in collaboration with the University of Modena and Reggio Emilia, the University of Parma, the University of Ferrara, and the Una Europa alliance of universities. The program combined OI with human centered design methodologies to understand problems from the users' perspective and to speed up the implementation of solution concepts.

[2] https://www.una-europa.eu/stories/una-ten

Tab. D. The implication matrix related to TEN

MOTIVATIONS		A	B	C	D	E	F	G	H	I	J	K	L	M	N	Out-degrees of row motivations
A	*Doing something helpful during the lockdown*		6(6)	4(4)	4(4)								1(1)			15(15)
B	*Feeling better during the lockdown*	1(1)														1(1)
C	*Feeling productive during the lockdown*	1(1)	5(5)							2(2)					1(1)	9(9)
D	*Sense of community*															0(0)
E	*Networking*											1(1)		4(4)	4(5)	9(10)
F	*Interest in the project*	1(1)	0(1)							1(1)	2(2)	1(1)		2(3)	6(7)	13(16)
G	*Doing extracurricular activities*								1(1)					1(1)	1(1)	3(3)
H	*Boosting experiences*						1(1)							1(1)		2(2)
I	*Prove themselves*	0(1)		2(2)					1(1)		1(1)	2(2)		0(1)	3(3)	9(11)
J	*Influencing and making better products/services*											1(1)				1(1)
K	*Enjoying the project*													1(1)		1(1)
L	*Generate novel solutions for novel problems*										1(1)	0(1)				1(2)
M	*Career development*										1(1)				1(1)	2(2)
N	*Personal development*					1(1)	2(2)	1(1)	1(1)					0(1)		5(6)
In-degrees of column motivations		3(4)	11(12)	6(6)	4(4)	1(1)	3(3)	1(1)	3(3)	3(3)	5(5)	5(6)	1(1)	9(12)	16(18)	71(79)

Tab. E. Information about the position of motivations in the TEN motivational structure and correlations among indices

	MOTIVATIONS	ABSTRACTNESS	CENTRALITY	PRESTIGE
A	*Doing something helpful during the lockdown*	0,17	0,07	0,01
B	*Feeling better during the lockdown*	0,92	0,05	0,04
C	*Feeling productive during the lockdown*	0,40	0,06	0,02
D	*Sense of community*	1,00	0,02	0,02
E	*Networking*	0,10	0,04	0,00
F	*Interest in the project*	0,19	0,06	0,01
G	*Doing extracurricular activities*	0,25	0,02	0,00
H	*Boosting experiences*	0,60	0,02	0,01
I	*Prove themselves*	0,25	0,05	0,01
J	*Influencing and making better products/services*	0,83	0,02	0,02
K	*Enjoying the project*	0,83	0,02	0,02
L	*Generate novel solutions for novel problems*	0,50	0,01	0,00
M	*Career development*	0,82	0,04	0,04
N	*Personal development*	0,76	0,08	0,06
ABSTRACTNESS		1,00		
CENTRALITY		-0,26	1,00	
PRESTIGE		0,58	0,56	1,00

Tab. F. Statistics for determining a cut-off level for TEN

Cut-off	(1) Number of active cells	(2) Number of active cells as a proportion of all possible (non-diagonal) cells	(3) Number of active cells as a proportion of all cells mentioned at least once	(4) Number of active linkages	(5) Number of active linkages as a proportion of all linkages
1	37	0,20	1,00	71	1,00
2	**14**	**0,08**	**0,38**	**48**	**0,68**
3	8	0,04	0,22	36	0,51
4	7	0,04	0,19	33	0,46
5	3	0,02	0,08	17	0,24
6	2	0,01	0,05	12	0,17

APPENDIX B: SURVEY TEMPLATE FOR ORGANIZATIONS WISHING TO REPLICATE THE STUDY

Description of the Survey

Motivations to attend the open innovation program X

In today's rapidly changing environment, innovation processes are becoming more open and an increasing number of organizations have started to adopt the open innovation paradigm. Recent research has pointed out that to make an open innovation strategy effective, it is necessary to understand the motivations of the people involved (i.e. why would individuals participate in an open innovation program and why would they contribute). This research focuses on the collaborative side of open innovation and aims to identify the motivations that lead people to voluntarily participate in open innovation programs.

- To participate in this study, you will be asked to fill in a questionnaire by reporting the motivations that led you to participate in the open innovation program X.
- You can complete the survey anonymously.
- The estimated time needed to complete the survey is 10 minutes.
- Some of the questions may seem redundant. Please try to be as complete as possible and try to explain your motivations in detail in the 3 stages of the questionnaire.

We hope you will share our enthusiasm for the research and agree to participate. Thank you for your time.

Student profile

First name (optional)	Enter your name
Last name (optional)	Enter your surname
Your email (optional)	Enter your email address
What university are you coming from? *	Enter your university of affiliation
Sex *	Dropdown format • Male • Female • Non-binary/Third gender • Prefer not to say
What edition of the open innovation program X did you attend? *	Dropdown format with all editions

Motivations (1st level)

What were your 4 main reasons for attending the open innovation program X?

- Please feel free to give your own honest reasons and try to be as complete as possible. If you prefer, you can also use a self-explanatory keyword.
- Leave a field blank if you cannot think of any other reasons.
- It is not necessary to rank the 4 reasons you choose.

An example of how to answer this question could be as follows:
"What are your 4 main reasons for losing weight?"

1. *I just thought I'd slim down and get ready for swimsuit season*
2. *I just want to control my diet to maintain a healthy lifestyle*
3. *Social appearance*
4. *Self-esteem*

Reason #1	Enter your 1st reason
Reason #2	Enter your 2nd reason
Reason #3	Enter your 3rd reason
Reason #4	Enter your 4th reason

Motivations (2nd level)

Why it was important to you to___:

An example of how to answer this question could be as follows

1. *"Why was it important for you to start getting ready for the swimsuit season?" Physical appearance*
2. *"Why was it important for you to control your diet to maintain a healthy lifestyle?" To increase the likelihood of living a long life*
3. *"Why was social appearance important to you?" Because I wanted to feel more comfortable posting pictures on social media*
4. *"Why was self-esteem important to you?" Because I wanted to feel more confident around other people*

${q://QID3/ChoiceTextEntryValue/1}	Enter why your 1st reason was important
${q://QID3/ChoiceTextEntryValue/2}	Enter why your 2nd reason was important
${q://QID3/ChoiceTextEntryValue/3}	Enter why your 3rd reason was important
${q://QID3/ChoiceTextEntryValue/4}	Enter why your 4th reason was important

Motivations (3rd level)

Why it was important to you to___:	
${q://QID9/ChoiceTextEntryValue/1}	Enter why your reason was important for the 1st reason given
${q://QID9/ChoiceTextEntryValue/2}	Enter why your reason was important for the 1st reason given
${q://QID9/ChoiceTextEntryValue/3}	Enter why your reason was important for the 1st reason given
${q://QID9/ChoiceTextEntryValue/4}	Enter why your reason was important for the 1st reason given

Please note that:

- Questions related to the '*Motivations (2nd level)*' block depend on the reasons given by respondents in the '*Motivations (1st level)*' block.
- Questions related to the '*Motivations (3rd level)*' block depend on the reasons given by respondents in the '*Motivations (2nd level)*' block.

To do this, the survey should be designed using the '*form field*' question type so that the survey can recall the answers given by the respondent in the previous block. Below we report an example of how it works in practice.

What were your 4 main reasons for attending the open innovation program Y?	
Enter your Reason #1	Trying myself in an international project
What it was important to you to	
Trying myself in an international project	I've never had this experience before and I wanted to try it
What it was important to you to	
I've never had this experience before and I wanted to try it	I want to pursue an academic career