Pairs as Pivots of Innovation: How Collaborative Sensemaking Benefits from Innovating in Twos

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Innovation is a collective and collaborative act. Even though ideas germinate in individuals' minds, they need social interaction to be improved and brought to realisation. Therefore, much attention is now being paid to team collaboration as an organisational essential for innovation. Collaboration facilitates the combining of perspectives, competencies, and resources. However, it has been shown that limits arise when it comes to converging views into a shared perspective and its interpretation. Innovation is not all about pooling competencies and resources but also about immersion and reflection. It is a process of collaborative sensemaking that benefits from intimate and close collaboration.

In this paper, we investigate how collaboration between twos, before an idea is shared with a large team, could facilitate the later collaborative sensemaking process through which the larger team must pass in bringing the innovation to reality.

Through a laboratory experiment, we prove how collaborating in a close relationship in a pair has a positive impact on collaborative sensemaking in a subsequent collaborative effort in a larger team setting. In particular, we demonstrate how the pair acts as a pivot in the larger team and accelerates the rate of growing perception and understanding of the innovative idea.

Keywords: sensemaking, pairs, dyads, innovation

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Introduction

Studies have shown that team collaboration presents significant advantages in innovation (Wiita & Leonard, 2017; Hammedi et al., 2011, Stam, et al., 2013). Indeed, collaboration in a team seems to enable the combining and connecting of different perspectives (de Dreu et al., 2008; Ilgen, 1999), competencies, and technical skills (Khurana & Rosenthal, 1998). Moreover, it enables the integration of thoughts and ideas through interaction (Stroebe & Diehl, 1994) and motivates individuals to higher performance through competition (Paulus & Brown, 2010; Beersma & de Dreu, 2005). Still, team collaboration in innovation is not all about combining and sharing of resources and competencies. It is a process involving reflection and motivation (Brenton & Levin, 2012), where values, empathy, and mental frames come into play (Schön, 1983). In a way, the development of innovation can be considered as a collective cognitive process in which people jointly shape shared understanding and values (Cox et al., 2003; Pearce & Ensley, 2004).

Traditionally, in the process of innovating, corporations ask people to work in teams to imagine and ideate a direction to take (a divergent phase of creation) and, simultaneously, align with that direction with a new shared understanding (a convergent phase of creation). This interplay between divergence and convergence is a collaborative sensemaking process in which the team hopefully comes together to an innovative shared interpretation (Berger & Luckman, 1966; Bruner, 2009; Goodman, 1978).

This shared understanding is essential for the success of a project. Team performances are positively related to the level of agreement of the entire team on the direction to follow (McComb et al., 1999). However, the tension between divergence and convergence poses

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important challenges. Convergence often implies conflicts, compromises, and bandwagon effects that undermine the shared understanding of the individual team members, which could reduce the engagement of the team members with going forward and weaken the process of innovation (Verganti, 2017; Van de Ven 1986; Tuckman, 1965).

Recently, scholars have studied how teams can overcome the strains and bandwagon effects that limit the teams' innovative ability (Villas-Boas, 2020; Guo, et al., 2017; Colombo, et al., 2017). Most of these studies consider teams mainly from a perspective of resource and competence and propose guidelines for achieving better innovations as teams (Shane & Ulrich, 2004; Luchs et al., 2015; Eling & Herstatt 2017). Therefore, we propose a complementary perspective for exploring how the collaborative sensemaking process that characterises innovation occurs and evolves when people collaborate. Specifically, on the one hand, the present study aims to investigate what happens when people do not gather in teams directly but pass through a more gradual process of collaboration and convergence (Weber, 2006; Charness & Yang, 2014). Little is known about the cognitive endeavour that underpins the transition from individual to collective sensemaking (Fellows & Liu 2016; Stigliani & Ravasi 2012). On the other hand, recent studies unfold how great innovations benefit from collaborating in small numbers rather than in large teams (Wu, 2020; Altuna et al., 2016). Therefore, in moving from individual sensemaking to collaborative sensemaking, the study investigates what happens when people take the preliminary step of working in pairs as the smallest collaborative units before forming larger teams (Simel, 1902a). Besides, some of the most significant innovations in recent years have been developed by pairs of individuals. Jobs and Wozniak invented the personal computer, Page and Brin invented Google, and Oppenheimer and Groves developed the first atomic bomb (Hunter, et al., 2012; Isaacson 2011). All examples that suggest how dyads elicit and instantiate novel and useful interpretations in organisations (Hunter et al., 2012).

Therefore, in such a context, we try to go beyond the more traditional resource-based model, by investigating how people pass through the collaborative sensemaking process when innovating could benefit from a close collaboration between a pair before it is taken up by a larger team.

Specifically, we investigate whether the pair can be the pivot in the collaborative sensemaking process in a team, aiming to converge into a new interpretation. Indeed, we propose that the close and secure environment provided by the pair not only facilitates the convergence process but also increases the probability of an individual bringing out their vision and making it more robust, thanks to the support of their partner (Farrel, 2003; Verganti, 2017).

To test our hypothesis, we experimented in a laboratory setting. We had the support of a control group of 83 students who were asked to address a brief aimed at innovating a product line provided by a company.

Results showed how the output developed by those teams that passed through a pair session (the treated group) was significantly more meaningful than those that worked directly as a large team (control group).

This paper is organised as follows. First, we delve into the theory of sensemaking to examine how it occurs in innovation. Second, after introducing pair collaboration, we present our hypothesis. Third, the methodology is presented. Finally, we discuss the results of the empirical evaluation, the implications of our theoretical findings, and their application.

Background Literature

Innovation is a collective and collaborative act even if ideas are framed in individuals' minds (Schilling, 2018). Ideas require social interaction to be improved and to become reality (Dell'Era et al., 2017; Trabucchi et al., 2017; Bjork, Magnusson, 2009).

Therefore, much attention has been paid to cross-functional teams as the primary organisational structure for innovation (Cox et al., 2003; Pearce & Sims, 2002). They can benefit from complementarity in perspectives (de Dreu et al., 2008; Ilgen, 1999), competencies (Khurana & Rosenthal, 1998), and leverage the ideas of the others (Stroebe & Diehl, 1994). Nevertheless, innovation is not only about technical resources, competencies, and skills, but also about cognition, reflection, and reframing (Brenton & Levin, 2017; Krippendorff, 2006). Taking this perspective, scholars recognise innovation as a collaborative sensemaking process where people jointly develop and create new shared understandings, values, and interpretations (Enninga & van der Lugt., 2016; Cunliffe and Coupland, 2012; Cox et al., 2003; Weick, 1995). The reason why innovation is strictly connected to sensemaking is twofold. First, innovation occurs not only as a result of a creative sparkle, but also, and above all, as the understanding of changes in the environment (Verganti et al., 2020; O' Connor et al., 2014). This is particularly evident in the early stages of concept and vision development where individuals aim to understand what is going on and look for a direction that provides the trajectory for further development (O'Connor & Veryzer, 2001; De Brentani & Reid, 2011; Khurana & Rosenthal, 1998). Sensemaking efforts, therefore, occur when the current state of the world is perceived to be different than expected and there is no obvious way to engage with it (Humphreys and Brown, 2002). This forces individuals towards searching for a meaning with which to deal with the encountered uncertainty. (Thiry, 2001; Maitilis & Christianson, 2014; Letiche et al., 2008). Thus, individuals move towards the search for new meanings as a way to deal with the uncertainty they face when approaching innovative scenarios (Boje et al. 2016;

Devine & Philips, 2001; Sivasubramaniam et al., 2012). Second, once the new scenario is made sense of, a team engages in creative activities to envision possible solutions (Enninga & van der Lugt., 2016; Pendleton-Jullian & Brown, 2016; Krippendorff, 1989). This creative activity implies initially to "imagine" a possible idea, concept, or product, and then a reflection on whether that idea makes sense in the new scenario. Thus, people rely on sensemaking even to develop outcomes which are plausible, persistent and sealed off from reputation in the new environment (Stigliani & Ravasi, 2012; Schön, 1983).

In this literature review, we look at the collaborative sensemaking process that takes place when people collaborate in innovation, highlighting what defines it, how it takes place, what it enables, and what it needs. We will see how it requires a certain level of closeness to enable the development of meaningful innovation. Therefore, we question if the collaborative sensemaking process people pass through when innovating could benefit from a gradual growth of the teams where people collaborate in dyads before entering a larger team. Finally, the hypotheses to be explored in this study are presented.

Collaborative Sensemaking in Innovation

Sensemaking is defined as a cognitive and emotional process through which people make sense of the discontinuities that happen around them (Weick, 1995). Individuals shape new meanings by leveraging the cues that they gather from their daily experiences, the environment, and the social context they live in (Weick et al., 2005; Fellows & Liu, 2016). More generally, this causes an individual to react emotionally to a discrepancy in the status quo when something novel or unique occurs. Therefore, when people try to shape new meanings it is because they are facing situations that have a certain level of uncertainty and ambiguity and require the invention of a new and more plausible scenario (Thiry, 2001).

This is exactly what people are required to do when dealing with innovation (O'Connor & Veryzer, 2001). During the process of innovation, indeed, ambiguities, uncertainties, and discontinuities abound and sensemaking is vitally important to the individuals involved in the process. In their study, Coopey et al., (1997) demonstrate that when the process comes to its end, shared meanings are synthesised into a single generic one that represents the essence of the innovation which facilitates and constrains future actions.

As stated previously, most of the time innovation benefits from collaborative efforts (e.g., Bjork & Magnusson, 2009). From a sensemaking perspective, joint sensemaking leads to innovativeness by the mediating effect of both tacit and explicit knowledge and absorptive capacity, which implies the ability of the individual to recognise and capture the value of information, assimilate it, and then apply it to innovation (Wang, et al., 2016). Thus, we see how considering innovation from a sensemaking perspective provides a richer and complementary perspective of how innovation happens, compared to the traditional resource-based models of innovation (e.g., Shane & Ulrich, 2004). Even, resource-based approaches are schema-driven rather than stimulus-driven and imply that people innovate through categorically based decision-making models (typical of problem-solving) without considering their inner perception (Maitilis & Sonenshein, 2010; Weick, 2010). Besides, sensemaking complements these approaches, by capturing the realities of agency, equivocality, flow, re-accomplishment, unfolding, and emergence; which are often obscured by the language of variables, nouns, quantities, and structures (Weick, et al., 2005).

Therefore, when dealing with innovation, individuals must succeed in the sensemaking process they are performing (Stensaker & Falkenberg, 2007). Indeed, if individuals do not resolve sensemaking challenges, that essence of innovation that both facilitates and constrains future action does not come into existence and, therefore, no action follows (Maitlis &

Christianson, 2014). As a consequence, innovation does not happen. Besides, innovation is linked to leadership and strategy making, both of which require the underpinning mechanism of individual and collective sensemaking (Fellows & Liu, 2016).

Exploring the dynamics that characterise the collaborative sensemaking process that happens when people collaborate in innovation, it is described in greater detail as an intersubjective process of knowledge creation (Dougherty et al., 2000). It involves the formation of an intersubjective space among people for the exchange of tacit knowledge (Nonaka, 1994). A possibly intersubjective construction is achieved when people interact and contradict each other, compare meanings to reach a possible stable one (Bouderbala & Zaddam, 2019). Using Nonaka's perspective (1994), it is an externalisation process of tacit knowledge that enables people to unveil new profundities and create connections among ideas to frame a new scenario. It takes place through creative abrasion, which mediates the transformation of individual knowledge into collective knowledge (Ahn & Hong, 2019; Hill et al., 2014). Still, the sharing of tacit knowledge is quite a delicate process, which produces insights and concepts in both verbal and non-verbal ways (Stigliani & Ravasi, 2012) based most of the time on gut feeling. Leonard and Sensiper (1998) highlight how sharing tacit knowledge requires time devoted to personal contact and, at the same time, can be inhibited by several factors such as the perception of inequality among individuals, the distance both physical and in time, and the group that prefers communication-based more on logical hard data. At the same time, the sharing of tacit knowledge is a necessary but not sufficient condition for innovation (Bertels et al., 2011). Scholars highlight how people need to cope with tensions that arise during an intersubjective sensemaking process. It is a spiralling process that juxtaposes different enactments and divergent phases with more convergent phases of selection and retention to arrive at a shared understanding (Weick & Westley, 1999). These tensions could either foster or compromise the entire collaborative sensemaking process and the resulting innovation. In

light of this, scholars suggest that to facilitate the establishment of comfortable communication of tacit knowledge, a certain level of closeness is required (Leonard & Sensiper; 1998)

Thus, this study aims to explore how collaborative sensemaking unfolds when people collaborate in an intimate environment that dyadic collaboration provides before engaging in a larger team.

How Pair Collaboration Enables Meaningful Innovation

In exploring the development of collaborative sensemaking, the pair has been considered as it represents the purest and most intimate form collaboration, wherein and individual shares their ideas and thoughts with another. It is the purest moment of encouragement, communion, and relational cohesion (Svejenova et al., 2010).

Along with these considerations, scholars agree that triads or larger teams are far less likely to succeed as pairs of individuals can succeed when dealing with innovation. Pairs seem always to lead to outcomes that have a unique signature (De Voogt & Hommes, 2007; Eisner & Cohen, 2010; Gronn & Hamilton, 2004; Petriglieri, 2019). The reasons why dyads prove to be better suited for eliciting and instantiating novel and useful ideas in organisations lie in its sociological features. Simel (1902, a) explains that in a pair, the co-responsibility of the individuals involved in collaborative action is perfectly visible and leads to a high level of mutual reciprocity. Each individual in a pair has only one other individual by their side, not may as in a team. Therefore, the departure of one individual may destroy the whole. On the other hand, even in the case of a triad, even if one individual leaves the team, the team may continue to exist (Moreland, 2010). The forces that prevail in a pair are those that spring directly from the partnership. In a way, people collaborating in a pair reach a unified state of feelings. Such as state is extremely difficult to be reached in a larger team, even that of only three people (Simel, 1902 a).

Apart from the sociological nature of a dyad, the two individuals in the pair engaged in innovation are bound together by their agreement over shared motives and understanding. The agreement and understanding provide the centripetal force that holds the pair in a relationship (Svejenova et al., 2010; Järvinen, et al.,2015). They are fundamental to the two individuals for the establishment of affective and cognitive trust, defined as the glue of the partnership (Mc Allister, 1995; Moreland, 2010).

In terms of dynamics, the pair is considered as the simplest form of a team (Pearce & Conger, 2002), and as a team, it embodies all the benefits and limitations, and some peculiarities. On the side of benefits, the pair embodies complementarity in competencies and skills, which is similar to a larger team (Alvarez et al.,2007; Shenk, 2014; Farrell, 2003; Hunter et al., 2012). Moreover, the pair provides psychological support to the single individuals and alleviates all the strains and stresses that people typically face in innovation (Hunter et al., 2017; Wright & Cropanzano, 1998). Thus, collaboration in pair seems to provide something more than what a traditional team provides, given that in a pair there is only one relationship through which emotions can flow. A dyad provides emotional encouragement crucial for facing the hurdles in innovation (Alvarez & Svejenova, 2005). In teams, this can be more complicated. Larger teams tend to establish norms that regulate the emotional experience of people. In a way, this could weaken the entire collaborative endeavour (Kelly & Barsade, 2001). Thus, pair collaboration seems to provide the right intimate space for the germination and development of innovation where a person feels free to share half-baked ideas and is more open to listening and focussing on critical feedback provided by the partner, which enables the reframing of the ideas to make them more meaningful (Rouse, 2020; Bellis & Verganti, 2019; Mashburn & Vaught, 1980).

As for limitations, as in larger teams, the pair experience differences of opinion, interpersonal conflicts, social loafing (Moreland, et al., 1996), and evaluation apprehension (Mc Grath, 2015) with some peculiarities. Though task-related conflicts are usually easily restrained, emotional conflicts can be sharper in a pair than in a larger team and even lead to abdication, (Reid & Karambayya, 2009). This happens because individuals interact more personally and openly with a single individual than with a team where blocking of production (Diehl & Stroebe, 1987) and the concern of being negatively judged are higher (Camacho & Paulus, 1995). Besides, the closeness in a pair enables the partners to interact more often and have a broader impact on one another, providing a higher sense of stimulation and enjoyment (Mc Grath, 2015).

In such a context, the study of dyads seems an excellent means for understanding the basis of the collaborative sensemaking process towards the achievement of a shared understanding that takes place during the process of innovation. Also, starting with the study of dyadic collaboration before moving on to the study of a larger team may provide insights into the evolution of the collaborative sensemaking process itself.

Hypothesis Definition

It emerged in the previous section that collaborative sensemaking is an intersubjective process that involves externalisation of tacit knowledge and its transformation into explicit knowledge (Dougherty et al., 2000). It is a quite delicate process of enactment, selection, and retention that enables people to frame new plausible meanings (Weick et al., 2005). We assume that pair collaboration seems to facilitate such a process to a greater degree for a couple of reasons. First, because of the closeness of the pair, each individual feels freer to share their thoughts, and, therefore, each individual's interpretations are more readily enacted (Rouse, 2020; Farrel, 2003). Second, since in a pair task conflicts are easily kept (Reid & Karambayya,

2009), tensions tend to be softer and, thereby, the selection and retention of new interpretations can be more natural and more effective within the boundaries of the pair. Moreover, as stated by Simel (1902, a), unique reciprocity and co-responsibility define the pair's relationship and prevent any kind of loafing in the relationship.

Therefore, even if, for the reasons of size, a pair could potentially not benefit from all the different perspectives and competencies as a larger team can (de Dreu et al., 2008; Ilgen 1999), because of the closeness in the pair, we can assume that pair collaboration outperforms teams in collaborative sensemaking for innovative purpose. Besides, the pair provides that psychological environment in which each individual feels free to share ideas and to submit them to the criticism of the partner to embrace a more robust and common interpretation (Farrel, 2001; Verganti, 2017). This typically does not happen in a larger team because of factors such as production blocking (Diehl & Stroebe, 1987), concern about being negatively judged by the other team members (Shenk, 2014; Camacho & Paulus, 1995) or the preference for communication-based more on logical hard data in preference over gut feeling and non-verbal communication which might facilitate the externalisation of tacit knowledge and thereby the collaborative sensemaking process itself (Leonard & Sensiper, 1998). In a way, as social complexity increases, people tend to shift from sensemaking driven by perception and emotional reaction to sensemaking based on categorical or hard facts (Weick, 2010). This shift is made in the interest of coordination (Maitilis & Sonenshein, 2010) adversely affecting the sensemaking ability. Therefore, from the foregoing, we may reasonably assume that the outcome of the collaborative sensemaking process is perceived as more meaningful by an individual when working in a pair than when joining a team directly. Thus, our first hypothesis is:

Hypothesis 1: The individual perception of meaningfulness is higher when collaborating in a pair rather than in a team.

Consequently, we are interested in investigating how the collaborative sensemaking process evolves once pairs of individuals merge into larger teams and compare this with a situation where people start collaborating in a team from the outset. At first glance, it is possible to suppose that once pairs engage others in innovation upon entering a larger team, the individuals begin a new intersubjective process. Thus, relying on the previous assumption, it is reasonable that this second process of sensemaking may benefit from a reduced number of interpretations to be selected and retained (Thrane, et al., 2010). Indeed, the team will have to select half of the interpretations each time because of the previous activity in pairs.

On the other hand, if people had moved directly from individual activity to teamwork, both the enactment of new interpretations and the selection and retention of new meanings would have been higher in complexity because of the higher number of interpretations to choose from (Wu et al., 2019). This would have entailed rejection of a larger number of interpretations and caused a greater and harsher degree of creative abrasion. This could lead to more difficulties in the process of convergence and would have been potentially detrimental to the success of the collaborative sensemaking itself. Hence, it is reasonable to assume that a team's collaborative sensemaking could benefit by having individuals collaborate closely in pairs wherein feelings, stimuli and cues are likely to flourish (Weick, 2010) before the pairs join the team. In a way, such a gradual process would enable individuals to recognise and capture the value of information, assimilate it in small doses and use it gradually for innovation (Wang, et al., 2016). In contrast, those who collaborated directly in large teams may prefer a more logical and rational communication (Sandberg & Tsoukas, 2015) in the interest of maintaining coordination (Maitilis & Sonenshein, 2010) at the cost of hindering the disclosure

of tacit knowledge, which may have adverse consequences for the individual's sensemaking process. This enables us to formulate our second hypothesis:

Hypothesis 2: The individual perception of meaningfulness is higher in teams where participants have previously collaborated in pairs.

At this stage of reflection, it could be worthwhile considering the transition of individuals from a dyadic environment into a team. In particular, once pairs merge into larger teams, we may expect the merging with other people to be critical for at least a couple of reasons. First, the intimate closeness in the pair is an intrinsic characteristic of the pair which cannot be replicated once others enter into the process of perception of meaningfulness (Shenk, 2014; Farrel, 2003). Second, having experienced the closeness during paired activity, dyads would come into the team with a stronger awareness of their own meaning, and joining with other people would necessitate entering into a new spiralling process and new selection phases. In this situation, each pair would be less inclined to retract from its well-considered perception of meaningfulness (Parker et al., 2015).

We can also think of some advantages. Indeed, we might expect the pairs to be highly motivated to move forward. Though they would not dilute their previous conclusions, they may engage even further with others in the search for a more advanced synthesis. From a sensemaking perspective, if individuals have reached a meaningful shared understanding while collaborating in pairs, to them the resulting meaning will represent the essence of the innovation they are proposing (Coopey et al., 1997). In a way, the meaning synthesised in a dyad would be a springboard for future actions. It would motivate people to move forward and look for even more meaningful interpretations (Maitilis & Christianson, 2014). Therefore, once the pair shapes a new meaning, a new trajectory is envisioned and individuals are engaged in the definition and implementation of this new meaning in the new scenario (Sandberg &

Tsoukas, 2015). Therefore, in joining a larger team, individuals will look for even more meaningful interpretation. Hence, we formulate our last hypothesis:

Hypothesis 3: The individual perception of meaningfulness in teams where participants have previously collaborated in pairs further increases thanks to teamwork.

Methodology

To investigate our hypothesis, we looked for the methodology that would best suit the study's purpose and opted for a laboratory experiment setting (Harrison et al., 2004; Levitt & List, 2009). This method was preferred over others, such as surveys and case studies for two reasons. First, a suitable population from which to select an adequately large sample (Rossi et al., 2013). Second, this method facilitated the testing hypotheses in a controlled environment set by the researchers and within which data could be collected without the sort of difficulties posed by external variables and the necessity of controlling a large number of variables.

This specific piece of research would provide the first evidence and open the way for research on the dynamics of pairs in innovation. Given its exploratory nature, this first experiment would be further leveraged by additional experiments and different methodologies (e.g., survey) to build the theory. Specifically, the aim of the study is directed at understanding differences between the outcomes of efforts of the team constituted of individuals who had previously worked in pairs and a team of individuals assembled directly. Once the difference is assessed, it would allow us to run experiments in the field without using a control group for comparison. This is of great importance because it would allow us to focus on the topic of interest in the course of in-the-field research that would benefit the companies and the researchers.

Context Description

The laboratory setting is chosen rather than a field experiment due to minimise external variables and thus so increasing internal validity. The experiment aims to test hypotheses related to working in pairs and teams on innovation. More specifically, with reference to those collaborative sensemaking processes in which people converge into new shared interpretations. To that end, and to achieve the generalisability of inter-team and inter-pair processes to any population in a situation that does not need specialised skills, a sample of students was selected.

Of course, the subjects of the experiment are distinct from the population to which we wish to generalise our findings. Therefore, we looked for a sample as similar as possible to the population of interest and suitable for the theoretical framework provided (Bissola & Imperatori, 2001). In particular, the individuals selected were students of a Master of Science course about innovation and entirely dedicated to the development of a team-based project for a company. In particular, students were asked to work on a brief of a live project for a company that needed help with innovating a business or product line in the coming years. Managers from the company attended the launching of the brief to the students to demonstrate their commitment to the project. Later, the managers periodically reviewed each teams' progress on the project.

In addition to that, some actions were taken to strengthen the external validity. Students attended lectures on the topics related to the research to simulate the atmosphere of a team working on the topic. Since the project work was a part of an academic course, the final evaluation of the students' academic performance depended directly on the successful development of the project. Besides this, the company's managers were to evaluate the project for 50% of the final score.

The sample included 83 students divided into teams of 4 or 5. Among the targeted students, nearly 80% had the experience of management of all the possible management functions in companies, such as finance, supply chain, operations, digital business, etc. The remaining were students of Design and had skills ranging from product-, service-, communication-design, etc. that are often required in innovative commercial projects (Alves et al., 2007).

In making the teams, the maximum level of internal heterogeneity and external homogeneity among the teams was ensured. In particular:

- The teams should have about an equal number of males and females.
- The average age and the academic path of the teams should be similar.
- The educational background of the team members should not be significantly different.
- The background in terms of the geographical location of the team members should not differ among different teams.

Since the project activity was spread over the entire semester, our experiment took place at a specific point in the course of the project. The project was divided into two phases. The first was the phase of envisioning. In this phase, the students were asked to frame a new possible innovative direction for the company in terms of the provided brief. In the second phase or the development phase, the students had to translate their vision proposed in the first phase into a feasible solution for the company. The development phase included the development of prototypes and a business model. The laboratory experiments took place exactly at the intersection of these two phases. The students were involved in our experiment at the point where they began translating their vision into a practicable product for the sponsoring company. This point represented a crucial time of collaborative sensemaking,

where the values, emotions, and perspectives embodied in the vision had to be translated into a compelling and plausible real solution (Pendleton-Jullian & Brown, 2016). Moreover, before starting the activity, the students' visions were reviewed with the company's managers who gave them feedback and suggestions to be considered in the development phase.

This team activity aimed to design a tangible deliverable and present its first draft within a set deadline. Thereafter, the team would have a week to refine the product for the next review with their professors and the managers from the company. To design the deliverable required the students to focus on some specific aspects that would enable them to translate their innovative vision into a convincing solution. In particular, students were asked to:

- *Define the opportunity to be seized and the related direction*: A clear description of the vision they had for the company in response to the provided brief

- *Identifying the user and the content requirements*: These were the constraints to be considered from a user's perspective (e.g., if the target user was an invalid, they would need a wheelchair), and a content perspective (e.g., if a domestic appliance was envisioned and IoT was a requirement, a smart home concept had to be considered)

- *Sketch the experience*: Design three possible scenarios that explained and translated the vision into an experience. These scenarios could be sequential or independent of each other, but each scenario had to embody the vision

- *Explain why the proposed solution is innovative, both for the company and for the addressed context*

- *Experiential value*: What would be the emotions/feelings that the customer/user should feel and not feel when the product was experienced

For the experiment, the term used for the students' delivered output was '*use-case*'.

For the experiment, the sample was divided into two groups. Along with that, we hypothesised that the reaction of each group to the treatment would be similar as a direct consequence of group selection, which happened to be studying the same master's degree course, which minimised the variance among them. Also, they had received the same inputs (e.g., the academic courses and the brief) and the same incentives for completing the experiment. Therefore, it was reasonable to assume that the groups would react similarly (Kagel & Roth, 1998). Thus, for our analysis to support the critical hypothesis, we had comparable treated group and the untreated group that did not differ in any relevant dimension that could influence the outcome of the experiment. Verification of the hypothesis would facilitate the comparison of the outcomes for the group the treated and the untreated groups without even the minimum inference of external and demographic variables (Friedman, & Sunder, 1994). The last step for maximising internal validity would be to not involve students in any experiment before and after the one described in the present study. This was critical for ensuring that their behaviour and consequently the outcome of the experiment were not influenced.

The Experiment Setting

The experiment presented in this paper was carried out as follows.

First, we divided the class of students into two groups – one of 28 students that was made of teams of four people to enable paired working they entered the team. The other group consisted of 55 students that was made of five-member teams that worked directly as a team.

Next, we asked the two groups to develop the provided brief by two different processes that are summarised in Figure 1 below.

INSERT FIGURE 1 HERE

To one group of students (GROUP 1, not treated) were given time to develop the use-case individually. Later, they were asked to form the team to develop a joint use-case together leveraging the individual student's outputs from the previous step.

The second group of students (GROUP 2, treated) was asked, after the individual use-case building activity to work with a partner from their team to further build the use-case and then join others to form the project team.

The decision to move from collaboration in pair and then in teams of four was aimed at increasing the procedural difference between the two experimental variations (pair and team) and to show more vividly the main differences in dynamics (De Voogt & Hommes 2007; Simel, 1902 a, b). Moreover, the considered sample had already been formed into teams of four students each.

Similarly, the difference in team size between treated (GROUP 2) and non-treated group (GROUP 1) is to be considered as a limitation of the specific context setting. The choice of the students of Master of Science course ensured similarity throughout the sample, which was necessary for selected the theoretical framework (Bissola & Imperatori, 2001; Rossi et al., 2013), and to control most of the external variables (Harrison et al., 2004). However, the team size could not be controlled. The teams in which students worked were the same as those for the semester-long project activity. Nevertheless, both the treated and the control group had the same structure (pair versus team). Besides, the slight variation in dynamics connected to the

size of the team (4 versus 5) is expected to be reduced with teams of very similar size, as the number of participants increase (Levine & Moreland, 1990).

Pairs of students in the treated group were formed randomly in the teams to minimise selection biases. Each student was asked to partner with the student seated to their right. Each step of the process lasted 60 minutes.

The Assessment Process

To test our hypotheses through the process, we performed three main measurements of both groups of students respectively:

- After step 1: the individual activity
- After step 2: the pair activity for the treated group and team activity for the control group
- After step 3: the team activity for both groups

Measurement is depicted in Figure 2 below.

INSERT FIGURE 2 HERE

To assess the development of the collaborative sensemaking process, all the measurements assessed the individual perception of 'meaningfulness', that is an assessment of the extent what was developed in that specific phase made sense to the single individual. Such a measurement aims to assess the perception of the embodiment and innovativeness of the new meaning perceived by each individual (Kijkuit & Van Den Ende, 2007). In a way, something is meaningful to an individual if it is interiorised by the individual and becomes part of their own knowledge and being (Cunliffe & Coupland, 2011). Also, when people shape new meanings, they try to discover non-existent structures, therefore they rely on inventions and

those inventions must be plausible, persistent, and sealed off from reputation (Weick, 1995). It is a process that springs initially from individual reflection and only later may evolve into a collaborative endeavour (Stigliani & Ravasi, 2012). Therefore, it was essential to give time to all the students involved in the experiment to reflect individually on their vision and understanding (individual sensemaking) of the deliverable assigned before beginning collaboration with someone else (a pair or a team) (Fellows & Liu, 2016).

In the next paragraph, we explain the assessment process in greater detail.

Assessing Meaningfulness

Measuring the level of meaningfulness or, more generally, the output of a sensemaking process is something that very few scholars have attempted. Usually, sensemaking is assessed using grounded theories (Coopey et al., 1997; Ravasi & Turati, 2005). Alternatively, scholars rely on factors related to sensemaking such as internal communication in the team, external communication, information gathering, information classification, and the ability to build shared mental models (Akgün et al., 2012; Lynn et al., 2000). Nevertheless, these studies do not consider how people perceived the final output of the process, though that is the essence of the process of innovation (Weick et al., 2005).

Therefore, to assess 'meaningfulness', scales that are consistent with the sensemaking construct definitions have been developed. Overall a survey of 23 items was developed. In designing the survey, scholars searched for the full domain of contents relevant to the particular measurement, oversampled selected words, and looked for the most comfortable way to assess this measurement (Carmines & Zeller; 1979). The intention was to create empirical indicators that could logically and theoretically be connected to the construct (Nunnally, 1978). Therefore, items have been developed starting from the theory of sensemaking. The theory of sensemaking explains how the creation of something that makes sense results in shaping a

meaning that is perceived by the individual as *tangible*, *plausible* and *credible* or *socially acceptable* (Weick, 1995; Pendleton-Julian & Seely Brown, 2016). Therefore, items incorporating these attributes have been developed. Besides, sensemaking is a conscious cognitive process in which people are engaged when they perceived that the new meaning is *novel*, *unique,* and *promising*. Thus, we asked about these attributes through dedicated items. Items were formulated in the following format: *'The use-case I developed is credible for the company'*. Finally, to reduce the risk of response bias in the form of acquiescence, some items were reversed (Churchill, 1979). For instance, in opposition to an attribute such as *plausible* or *credible*, we formulated items stating *unconvincing* or *vain*.

All the items were assessed on a 7-point Likert scale ('1' stands for *'not at all'* and '7' stands for *'completely'*). Following the procedure advocated by Churchill (1979) for content validity, the list of items was submitted to four academicians to assess their intelligibility of the constructs according to the purpose of the assessment, and their theoretical validity. Besides, the survey was submitted to managers from the company that sponsored the project to verify that the survey was easy to understand for them as well and to be sure that they interpreted the items as we intended them to be interpreted, theoretically.

During the experiment, the survey was carried out after each step of the process during times dedicated to reflection. The creative activity was interrupted, the students were requested to spend ten minutes to respond to the survey. The survey was delivered online via a mobile application.

To extract the factors and assess unidimensionality, an Exploratory Factor Analysis (EFA) was performed. The EFA was performed with a purely exploratory purpose. The aim was to identify those indicators that form a unidimensional factor and, thereby, provide the basis for measurement (O'Leary-Kelly & Vokurka, 1998).

Before running the EFA, a preliminary data analysis was made to check data quality. In particular, outlier or non-valid answers were discarded. The final database included 66 observations, 25 from the treated group, and 41 from the control group. To perform the EFA, all the individuals' answers to the first step were used because it was the step in the experiment that was common to control and the treated group. To extract factors, the items with a factor loading lower than 0,6 were discarded (O'Leary-Kelly & Vokurka, 1998). As a result, two factors were extracted. The former (Cronbach Alpha = 0,9; Eigen Value = 4,633), included items that described certain attributes with such adjectives as 'plausible', 'credible for the company', and 'promising'. This meets with Weick's (1995) explanation that something makes sense if perceived as plausible, persistent, and sealed off from reputation. Therefore, it was labelled with the name *plausibility*. The latter (Cronbach Alpha = 0,871; Eigen Value = 1,068) includes items related to attributes such as 'innovative', 'novel' and 'unique'. This is coherent with the innovative essence of sensemaking, which enables the discovery of structures that are not there (Weick et al., 2005). Therefore, this was labelled with the name *novelty*. Table 1 shows the results of the EFA and the factor loading for all the items.

INSERT TABLE 1 HERE

Given the untested and exploratory nature of the measure, non-refined methods were preferred to define factor scores (Hair et al., 2006; Tabachinck & Fidell, 2001). Besides, to retain the scale metric that may allow easier interpretation and enable comparisons across factors that contain different numbers of items, the average scores were computed (Di Stefano, et al., 2009).

Results

In this section, we present the results of our laboratory test.

Given the moderate size of the sample, a non-parametric test was preferred over a parametric one (Lumley, et al., 2002). In particular, a Mann-Whitney U test was selected, given that it has been proved to be as powerful as a more classical parametric t-test for small or moderate sample sizes (de Winter & Dodou, 2010). In the following paragraph, we explore the results of the analysis and present the results for each hypothesis in Table 2.

To explore our first hypothesis, the Mann-Whitney U test was performed on the data gathered after the second step, comparing the treated and the control groups. The hypothesis is verified for the first factor (*p-value*. = 0,000), but not for the second one, where despite the mean range stated for higher novelty perception within the treated group, the test was not significant (*p-value*. = 0,097). This implies that working in pairs facilitates the development of sensemaking, but the outcome is not always perceived as being more innovative when working in pairs than in teams.

For our second hypothesis, we analysed the data gathered after the third step, where both groups worked in teams. The hypothesis results were verified for both the first and the second factor (*p-value*. = 0,000), which indicated that those teams that worked in pairs during the second step, not only perceived the output of the teamwork as being more plausible than the teams of the control group but also were more novel.

Finally, for our third hypothesis, a new variable was created for both factors, namely, the difference between the score of the third step and the score of the second step. This hypothesis is verified if the mean range of the treated group is significantly higher than the mean range of the control group. Unfortunately, the hypothesis is not verified for the first factor

(*p-value*. = 0,406) and only partially for the second one given that the significance value is very close to the acceptance threshold (*p-value*. = 0,064).

INSERT TABLE 2 HERE

Discussion

The purpose of this paper is to investigate how collaborative sensemaking evolves when people are asked to innovate together and if it can benefit from a gradual growth of the large innovation team by bringing together individuals who have passed through pair-work. Through an exploratory analysis of the factors, we identified two main factors that help us understand whether something makes sense to individuals, namely, *plausibility* and *novelty*. Figure 3 shows the mean value for the factors for the second and the third steps, comparing the treated and control groups.

INSERT FIGURE 3 HERE

Overall, we demonstrated how the perception of *plausibility* is higher when team size grows gradually, and people have the opportunity to share ideas and thoughts in the close environment of a pair before joining a larger team.

In particular, it emerges that the delicate intersubjective process of meaning creation benefits from the intimate space provided by the pair – a comfortable environment that encourages the disclosure of tacit knowledge. In such an environment, individuals are more open in listening to one another and open to creative abrasion, which mediates the transformation of individual knowledge into collective knowledge (Ahn & Hong, 2019; Hill et al., 2014), leading to a meaningful outcome. Beyond these considerations, this transformational process seems to be facilitated by pairs' sociological nature (Simmel, 1902 a,b). The sense of co-responsibility provided by pair's collaboration may hinder or reduce to a greater degree such phenomena as social loafing (Staats et al., 2012; Schnake, 1991) or free-riding (Albanese & Van Fleet 1985; Olson, 1965) as compared to larger groups.

Also, it was seen that the perception of plausibility in the team made up of members who had worked on that aspect in pairs (the treated group) was higher than for the control

group. Though the control group had more time to establish an environment of collaboration (they started to collaborate as a team from the second step of interaction) and the benefit of the greater cognitive diversity, the treated group performed significantly better.

These findings demonstrate how pair-work directly boosts the growth in plausibility perception and thus the individual's sensemaking. This reflection is supported by a few more considerations. First, after the second step, the *plausibility* perception was significantly higher for those who worked in pairs rather than in a team. Second, surprisingly, in moving from step 2 to step 3, growth rates in *plausibility* perception for the control group and the treated group were not significantly different (*p-value* = 0,406). Still, the treated group registered a higher level of *plausibility* perception for team collaboration, as anticipated in our second hypothesis. These findings suggest that working in pairs acts as the pivot of the collaborative sensemaking process in innovation teams. It can be related to the fact that individuals are more likely to interact more openly and personally with an individual rather than with a group where the concern of being negatively judged is higher (Shenk, 2014; Stam et al., 2013).

Similar considerations can be put forward for the perception of *novelty*. Overall, the perception of *novelty* is higher when the team size grows gradually, and people can share ideas and thoughts in the intimate environment of a pair before joining a larger team. Therefore, even in this case, the pair seems to act as a pivot in the collaborative sensemaking process even though it is not directly demonstrated in a direct comparison of pair collaboration with team collaboration. Indeed, we observed how in the second step of our experiment there was no significant difference between the control and treated groups in the perception of *novelty*. Still, it is quite interesting. We might have expected that team collaboration leads to a higher level of innovativeness perception than pair collaboration because of the availability of more competencies, resources, and perspectives to be integrated towards an innovative outcome.

However, our data suggests that this is not true. Even in pairs, an innovative outcome unfolds. These considerations suggest that even if competencies and resources are relevant for innovation, they are not sufficient. Reflection and immersion seem to play an important role in the development of meaningful innovation (Brenton & Levin, 2017). The environment provided by the pair seems to encourage those factors that complement the need for resources and competences in innovation and lead to more effective collaborative sensemaking processes.

Overall, these findings seem to confirm our assumptions. On the one hand, it appears that, for the treated group, the enactment of the new interpretations, their selection and the subsequent retention benefit from a reduced number of interpretations to choose from and to be synthesised in a shared new meaning (Thrane, et al., 2010). On the other hand, from a sensemaking perspective, it seems to confirm that the meaningfulness perceived by individuals during pair activity represents a springboard for future actions, it motivates people to move forward and look for even more plausible and novel interpretations (Maitilis & Christianson, 2014) in the subsequent team activity. Therefore, in joining a larger team, individuals who had worked in pairs will look for an even more meaningful and compelling outcome (Sandberg & Tsoukas, 2015).

Finally, our findings seem to confirm what Shenk (2014) argues about the difference between pairs and teams of more than two people. Two are not three or four. Indeed, even if only one more person is added to a partnership, the situation becomes more stable. However, this can stifle creativity as roles and power positions arise.

Conclusions

When a team of individuals is asked to collaborate in innovation, perform a collaborative sensemaking process. Scholars demonstrate how such a process is not free of tensions and conflicts as the integration of different interpretations towards convergence into a shared meaning is attempted (Weick 2001; Dougherty et al., 2000; Thrane, 2010).

In this paper, we demonstrate how new interpretation unfolds gradually through a collaborative sensemaking process. In particular, we provide insights into the functioning of the intimate environment of pair collaboration as a pivot that accelerates the growth of meaningfulness perceptions. From an individual perspective, the pair appears as the first instance in which the person does not innovate alone but exchanges opinions with someone. Therefore, it is quite a delicate moment that can foster or kill the willingness and motivation of the individual to move forward (Rouse, 2020). In a way, the pair-work is the first moment of encouragement and the purest form of intimacy. Our study shows how the sensemaking process benefits from the personal intimacy provided by the pair which establishes a comfortable environment for the sharing of tacit knowledge among individuals. This preliminary activity of sensemaking performed in a pair even facilitates the subsequent activity of sensemaking in a larger team. Indeed, after pair activity, when individuals enter a larger team, the individual's perception of meaningfulness continues to grow.

Our study suffers from certain limitations. The main limitation is related to the laboratory setting used for the experiment. Though the selection of a representative sample from the population of interest could have been possible, we faced some limitations. One was the difference in team size and it was the most critical limitation. However, this potential bias seems to reinforce our findings. We could expect that teams of five benefited by the availability of higher cognitive diversity and, therefore, would lead to more plausible and novel outcomes

than a team of four. However, this did not happen, as discussed in the previous section of this study, the control sample showed a lower performance though it had larger final resources. Despite these limitations, given the exploratory nature of the study, the laboratory setting seemed most appropriate. Future studies should consider field setting for replication and validation of our results. The field setting may even provide additional insights that cannot be inferred from the laboratory study.

Besides, within the experiment, pairs were formed randomly without anticipating how an individual's characteristics and relative characteristics of the pair may impact the collaborative sensemaking process itself. Still, this provides a crucial point for further explorations into dyadic collaboration. Further, the study opens an avenue to additional issues such as free-riding (e.g., Villas-Boasas, 2020; Albanese & Van Fleet, 1985) and social loafing (e.g., Staats et al., 2012). Our findings seem to suggest that when collaborating in a pair, free-riding and social loafing are less common. This confirms other scholars' findings (Levine & Moreland, 1990). Still, these assumptions require deeper examination.

To conclude, the study contributes to both literature and practice. From an academic point of view, this study contributes to innovation literature from the perspective of sensemaking and provides insights into collaboration in innovation, how it occurs, and can lead to better results. Indeed, in a world that is rapidly changing, innovation is no longer seen merely as a set of activities or competencies to be managed, but as a process in which people as individuals play an essential role. It implies that, over and above competencies and skills, emotions, values, and perspectives play a part in the envisioning and shaping of innovative scenarios. Understanding how to deal with these factors is essential not only for the theory of innovation but also for in practice for companies and managers. The paradigms of sensemaking provide a stimulating perspective for dealing with these topics and looking at people dynamics

in the context of innovation. Also, by focussing on pairs, the study of such dynamics enriches the literature related to collaboration in innovation by attempting to explain the dynamics that take place when two individuals collaborate and how they reach the level of intimacy necessary for innovation. From a managerial perspective, this study provides a process that fosters the collaborative sensemaking process through which people pass when innovating and facilitates the convergence towards a shared and innovative meaning. Also, the study casts light on the micro phenomenon of pair collaboration, which can have a significant impact on an organisation dealing with innovation. Indeed, when managers placed in an innovative scenario, they must understand how people in their company are embracing change, how they are making interpreting it. Indeed, sensemaking is a micro-mechanism that produces macro-changes over time (Weick et al., 2005). Pair perspective seems to enable a better understanding of those micro-mechanisms that can help managers and companies to better support people in embracing the change and make the treading of the path towards innovation a bit easier but at the same time create value for the organisation.

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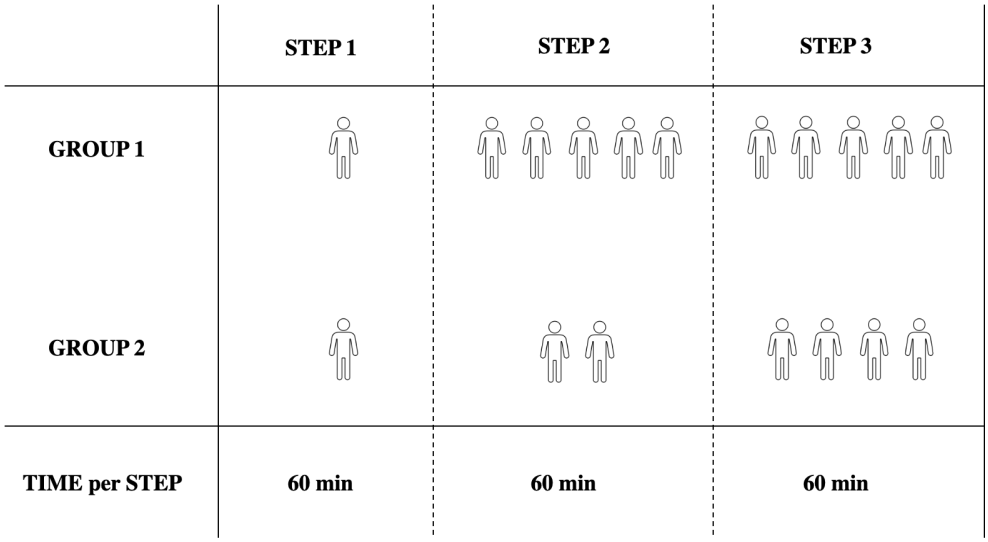

Figure 1 - Experiment Process: the sample was divided in two groups, which answered to the same brief but followed independent processes

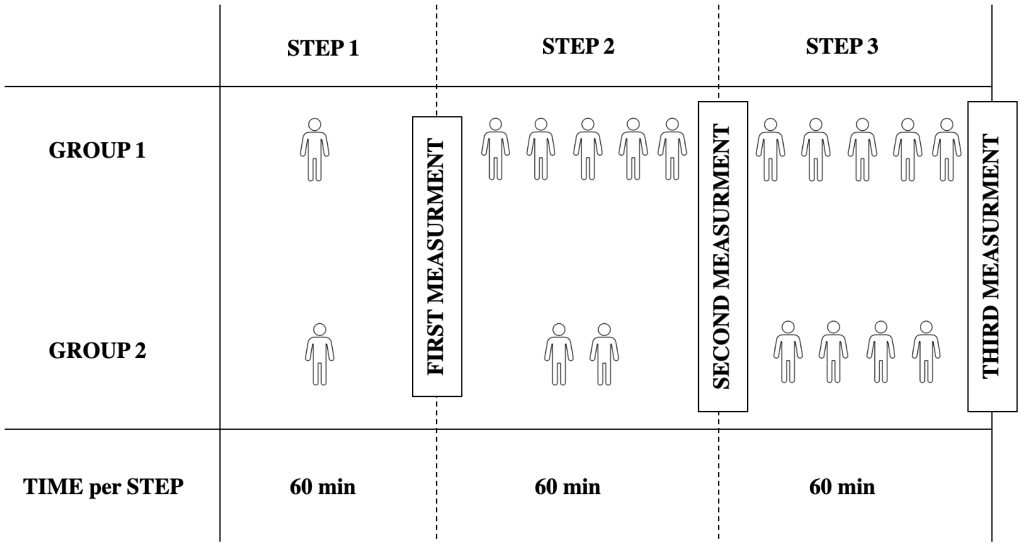

Figure 2 - Treatment measurement: after each step of the process a measurement of the meaningfulness perception was performed

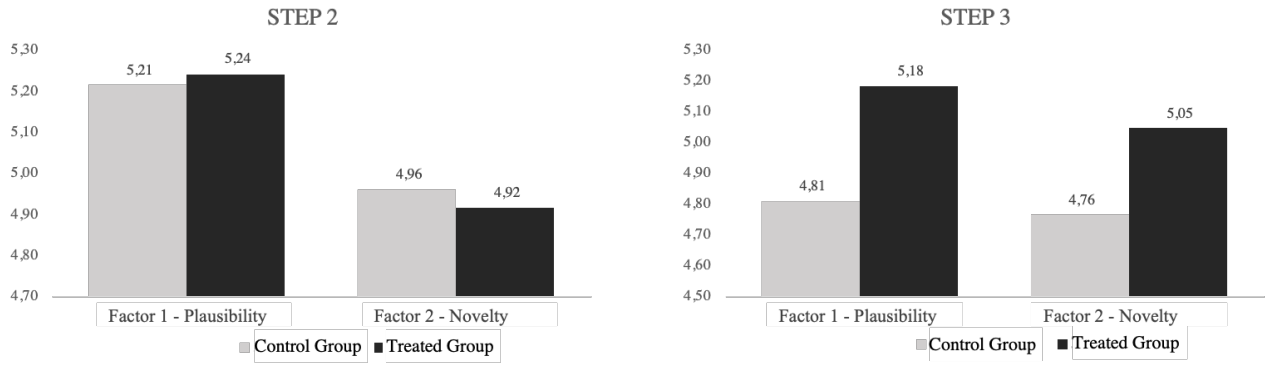

Figure 3 - Comparison of the mean for both Factors across the different steps. It emerges how the two groups performed differently

Extracted Items	Factor 1 (Plausibility)	Factor 2 (Novelty)
The use-case I developed is plausible	0.765	
The use-case I developed is credible for the company	0.756	
The use-case I developed is promising	0.708	
The use-case I developed is effective	0.706	
The use-case I developed is compelling	0.673	
The use-case I developed is unique		0.658
The use-case I developed is novel		0.656
The use-case I developed is innovative		0.602

Table 1 - Factor Extraction - Factor 1 (Plausibility): Cronbach Alpha = 0.9; Eigen Value = 4,633; Factor 2 (Novelty): Cronbach Alpha = 0,871; Eigen Value = 1,068

Factor 1 (Plausibility)		N	Mean Range	Mann-Whitney's U	Wilcoxon's W	Z	Sig.
Hypothesis 1	Treated Group	25	43,78	255,5	1116,5	-3,551	0.000
	Control Group	41	27,23				
Hypothesis 2	Treated Group	25	45,2	220	1081	-4,026	0.000
	Control Group	41	26,37				
Hypothesis 3	Treated Group	25	35,82	454,5	1315,5	-0,831	0,406
	Control Group	41	32,09				

Factor 2 (Novelty)		N	Mean Range	Mann-Whitney's U	Wilcoxon's W	Z	Sig.
Hypothesis 1	Treated Group	25	38,38	390,5	1251,5	-1,662	0,097
	Control Group	41	30,52				
Hypothesis 2	Treated Group	25	41,32	317	1178	-2,671	0,008
	Control Group	41	28,73				
Hypothesis 3	Treated Group	25	38,68	383	1244	-1,851	0,064
	Control Group	41	30,34				

Table 2 - Results of the Hypothesis tested on both factors