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The use of Open Innovation in the Requirements Engineering Practice
An Empirical Investigation

Bachelor of Science Thesis in Software Engineering and Management

STEFANIA FERNANDEZ

University of Gothenburg
Chalmers University of Technology
Department of Computer Science and Engineering
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<div align="right">Stefania Fernandez, May 20015.</div>

The Use Of Open Innovation In The Requirements Engineering Practice: An Empirical Investigation.

Stefania Fernandez

Department of Computer Science and Engineering

University of Gothenburg

gusramist@student.gu.se

Abstract : *In this paper we present the results of an empirical study carried out to gauge common experiences within open innovation (OI) practices in the requirements engineering (RE) process. The purpose is to understand the barriers and drivers and measurement of innovativeness that the implementation in the RE may enforce. A total of 35 participants answered the compulsory questions of the survey, which results are the main contribution to the study. Our results show that implementing requirements in an open innovation context can be challenging, as requirements and implementation are freely available for several potentially contributing organizations. However, our results show that OI in RE is becoming more and more fully exploited from both the outside and inside and it is useful for most development process type. Potential drivers such as new generated ideas and higher costumer benefits are only some of the drivers mentioned among participants that implement OI requirements, barriers such as hard to find the right partner and innovativeness such incremental innovation are also revealed in this study.*

Keywords: Open Innovation; Requirements Engineering; Open Source Software; Ecosystems.

1   Introduction

Exploiting viable business opportunities to generate profit have become the main goal of today's software organizations [1]. Accomplishing and maintaining competitive advantages have become more and more challenging due to the constantly (and uncontrollable) growing of technology [2]. For organizations to remain competitive innovation is considered a key factor to gain entry to new markets and challenge established market leaders [2][3]. Edison et al. [2] stress that in today's competitive business environment, quality is necessary but not sufficient. Organizations must continuously innovate, develop and deliver new products, in order to sustain profitable. Certainly, in most markets' domains, innovation is being dependent on software components, even in industries that traditionally were not software centric [4]. This

growing importance of software in today's products and services puts lot of weight on excelling the discovery, description and execution of innovation [3][5].

In recent years, a majority of the innovation within software has been increasingly reliant on a new paradigm called *Open Innovation* (OI), which is typically, but not necessarily, implemented by using *Open Source Software* (OSS) [5]. The influence of OI has, lately, become significantly important in the development of software products and services, e.g. in the android ecosystem [3][5] (note that open innovation is not open source). Chesbrough [6] defined *open innovation*, as the act of identifying and adopting external generated innovations into a single organization, with the purpose of creating new sources of technology and growth. The paradigm assumes that organizations can and should be open to use both internal and external ideas to create better solutions that boots innovation and expands the markets [6][7]. From one perspective, organizations cannot longer depend entirely on their own internal innovation [1][5][8]. Todays' software development effort is rarely constrained to a single company, investing into developers, technology, marketing and sales, instead, they form alliances to participate and benefit from the capabilities offered by, e.g. a software ecosystem [8].

Since the role of innovation is related to creating or eliciting requirements [1][6], from the perspective of generating profit, software organizations should focus on identifying and implementing the most beneficial and appropriated functionality, to fulfill customers' needs and expectations [9]. Unfortunately, this task is commonly underestimated, as during the software engineering process, requirements are often considered equally important and not ranked or prioritized with a value [10][11]. The requirements engineering practice is, undoubtedly, a fundamental activity of software engineering to identify, analyze and specify important requirements that will further sent to implementation [9][10]. Traditional requirements specification has mostly focused on internal (within the organization), also *closed innovation* [6], stakeholder interaction. This approach is, though, threatened by the need to adapt to a world of rapid change and intense market competition. Here, open innovation plays an important role to provide growth opportunities [5][6][11], and extending the lifecycle of already existing products.

Open innovation, on the other hand, supports a wide range of internal and external technology sources, as well as commercialization channels [12] that may not be aligned with the current business model (e.g. via licensing or sale), addressing though different problems (e.g. "PARC Problem" experienced by the Xerox company [1]). In the requirements engineering practice, problems may exists in e.g. market-driven projects, as not all the requirements can be implemented in the product [10][11], wasting thus, all the generated ideas that were not commercialized, due to, for instance, a lack of alignment with the overall business model and product portfolio of a company.

Several researchers have explored the open innovation paradigm, focusing in many different aspects [3][5]. However, little empirical study has endeavored to examine the role of open innovation in the requirements engineering process and to identify possible new challenges and measurement of innovativeness presented by the phenomenon. Some researchers [1][5][6], on the other hand, have identified a gap in understanding the impacts of open innovation in the requirements engineering process. Wnuk and Runeson [5] suggested that providing empirical evidence, using ap-

propriated techniques and analyzing the outcomes of these techniques could foster open innovation. Enkel et al. [3] presented a list with barriers and challenges that organizations faced during the implementation of OI practices, e.g. coordination costs. They mentioned requirements engineering processes among the areas where further research is needed.

This paper explores the requirements engineering process in an open innovation perspective. We conducted an empirical study at software-centric development organizations (note that we focus on organizations that are partly or completely directed to the development of software products and services, e.g. telecommunication, automotive, web etc.). The main goals with our empirical study is to 1) gauge how common OI is in the RE practice and to what extent it is implemented, 2) identify the drivers and barriers of OI in the RE, and 3) find out if the implementation of OI actually leads to new innovation and if so, what kind of innovation. This paper is organized as follow: Section 2 presents the relevant background and related work. Section 3 presents the research methodology, study design and operation, and Section 4 presents the results. Finally, we discuss the results in Section 5 and present conclusions in Section 6.

2   Background and Related Work

In this section we present the background of the topic in study and related work found in literature.

2.1   Background

Open innovation was originally defined by Chesbrough [6] as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". The paradigm assumes that organizations can and should use internal as well as external ideas and paths to market, in order to advance their technology [6]. Lichtenthaler [12], proposed a similar but refined definition: "An open innovation approach refers to systematically relying on a firm's dynamic capabilities of internally and externally carrying out the major technology management tasks, i.e., technology acquisition and technology exploitation, along the innovation process". Lichtenthaler maintained that open innovation processes involve a wide range of internal and external technology sources as well as commercialization channels [12]. This increased sharing of knowledge could in turn lead into more *disruptive* or *radical* innovations (e.g. innovations that introduce first time features or exceptional performance [2][3]) coexisting with *sustaining* or *incremental* innovations (e.g. continuously improving solutions to create more value [2][3]). Both Chesbrough and Lichtenthaler set their work in the context of medium to large organizations, organizations that perceive innovation as one means (among many) to maintain or expand market share. Relying in consistency, this thesis focuses on Chesbrough definitions.

Innovation itself can be described as the ability to dictate and/or modify the 'rules of the game' that enables organizations to gain entry to new markets and challenge

the already established market leaders [2][13][14]. The OECD [14] classifies innovation into four main types in the Oslo manual: *product, process, marketing* and *organizational*. *Product innovation* refers to the creation and introduction of new products that may bring new value to customers at small production and distribution costs, e.g. the software itself [2][5]. *Process innovation* refers to the implementation of a new design, analysis or development model that changes the way products are created, e.g. OSS communities [2][5]. *Marketing innovation* refers to new methods, strategies and concepts in the product [5], e.g. offering services at the price of being exposed to ads or sharing information [2]. *Organizational innovation* refers to the implementation of a new organizational method in the business practices, workplace or external relations, where open innovation is an example [2].

Enkel et al [3] defined three different processes that can be differentiated in open innovation. These are: the *outside-in*, the *inside-out*, and the *coupled*. The *outside-in* for instance, enriches the company's own knowledge by introducing suppliers, customers, and external knowledge sourcing. This process can increase innovativeness at organizations [3]. The *inside-out*, refers to maximizing return of investment by transferring ideas to the outside market, e.g. selling IP, and multiplying technology. Here, organizations focus on externalizing their knowledge and innovation with the purpose of bringing ideas to market much faster than they could through internal development [3]. The *coupled* process refers to co-creation with other partners, e.g. alliances, cooperation, and joint ventures, where give and take are necessary for success [3]. Organizations that use coupled process combine the *outside-in* process with the *inside-out* process, to jointly develop and commercialize innovation.

Software, with its flexibility in multiple aspects, is an excellent enabler for innovation. This flexibility must, however, be managed not to lose control over the software. In an OI context, *software engineering* (SE) may be a major research challenge since engineering practices for contract-based, e.g. in-house, development may not be feasible [5]. On a Market-driven development project, other issues may exist e.g. in the requirements engineering process, where not all the requirements can be implemented due to, for example, a lack of alignment with the overall business model of the company. As experienced by the Xerox (company) [1], the inability to assess and capture value for technology innovations that were not directly related to Xerox products, wasted all the ideas generated. Also balancing between market pull and technology push, cost-value estimation and overloaded requirements are considered challenging aspects [1][11].

Software processes that include open innovation practices, combine internal and external ideas into architectures and systems, and utilize business models to define appropriated requirements for these architectures and systems [6][7]. Because the role of innovation is related to creating or eliciting requirements, the requirements engineering process become a key activity. Prioritizing which of the incoming requirements to implement is fundamental for developing software products that meets customers' needs and expectations [11]. Since only some requirements can be implemented due to limited resources, prioritization techniques need and should be implemented in order to find the most suitable requirements [9]. However, during the open innovation practice, this task is generally considered challenging due to several reasons [1][10]. Firstly, in a closed innovation model, experts estimate the cost for im-

plementation and the market value is estimated using market research or business intelligence activities [7]. In an open innovation model, (e.g. when an organization uses an OSS idea/feature/requirement as the basis for their software products), the cost could be low (only the integration cost should be sustained) [1][7], but the market value of the innovation could be limited by the fact that competitors may be using the same open source solution as the company itself [1][7].

2.2 Related work

The open innovation paradigm has been explored by several researchers focusing mostly on the business management perspective [6][3][8], in terms of corporate venturing and valuation using a real options model [5][8], technology industries [5][8] and to determine if open innovation is unique to large companies in 'high-technology' industries [3][6][8]. In SE, OI is still an emerging paradigm that can greatly accelerate technical knowledge innovation at software development organizations. In recent years, the influence of OI has become significant in the development of software products and services. Mechanisms such as Open Source Software (OSS), as well as Ecosystems, may embody the principles of open innovation. OSS, on the other hand, is not a new phenomenon on its own, but its widespread adoption in industry may require new approaches to software development, and thus, implementing new requirements [5][8]. The same applies to Ecosystems, where a network of collaborators constituting a community is open [5][8]. Combining all these aspects allow us to investigate an area that is not extensively covered by researchers.

Researchers such as Wnuk and Runeson [5] presented a literature review where their goal was to develop new or adapt existing practices into a software engineering framework that meet challenges in the multi-organizational, heterogeneous open innovation context. Their focus was on OSS communities, such as Android ecosystems. The proposal of the framework was developed to foster open innovation by designing and tailoring appropriate software engineering methods and tools. Even though their study remained incomplete, they were able to identify software engineering areas where further research was needed, e.g. requirements engineering.

Enkel et al. [3] explored the outside-in and inside-out process of the open innovation phenomenon. Their study showed, how certain (also well-known) organizations were able to increase their product success rate by just introducing the OI concept to the organizations. However, they mentioned that companies investing in open innovation activities face risks and barriers that hinder them from profiting from their initiatives, such as loss of knowledge, higher coordination costs, as well as loss of control and higher complexity. Other significant internal barriers were found, such as the difficulty in finding the right partner, imbalance between open innovation activities and daily business, and insufficient time and financial resources for open innovation activities [3].

Further, Jansen et al. [15] created a model to provide an insight to openness options that could help software organizations to determine their openness strategies. Their model was useful to show that organizations could choose to be open to "both the supply and the demand side of the supply chain". They identified that openness could quickly create an increasingly amount of partners around the product, "if and

only if the surrounding partners were ready and prepared to enter the ecosystem" [15]. However, since the prerequisite of Ecosystem is open platform, competitors may attempt to take competitive advantage via the platform, thereby forcing the organization to follow rather than lead [15].

The Requirements engineering practice is partly based upon the belief that successful software product definition is inevitably related to accurate identification and implementation of customer needs, needs represented as various types of requirements [1][11]. Traditional requirements specification and identification has focused on internal stakeholder interaction (also called closed innovation [6]). As Chesbrough [6] noted, not all the smart people work inside the company but in the outside as well, thus, firms need to "learn how to play poker as well as chess" with their innovation processes. According to Chesbrough, the use and/or experimentation of external generated innovation can provide, in short-term, growth opportunities, extending the lifecycle of existing products [6].

While related papers described different aspects associated to open innovation [1][2][6][15], little empirical study has endeavored to examine the role of open innovation in the requirements engineering process and to identify possible new challenges and measurement of innovativeness presented by the paradigm. Some researchers [1][3][5][15], however, identified research areas where both practitioners and researchers can benefit from further investigation, such as requirements engineering, software design, software development and software testing techniques for open innovation. Additionally, they suggested that providing empirical evidence, using appropriate techniques and analyzing the outcomes of these techniques could foster open innovation.

3 Research Methodology

For this study, we used a quantitative survey as research methodology. The survey was executed through the creation of a structured and self-administrative on-line questionnaire to gather data and generalize it from a sample to a population. We used survey because we wanted to get a general and overall knowledge of the topic in study. A case study would not have been suitable, as it require the setting of a real environment, and this would not have been feasible since we wanted to reach out as many companies as possible. Surveys, on the other hand, are an appropriate strategy for getting empirical description about trends, attitude and/or opinions of the population in study [16][17], and are useful for analysing large population, given the adequate response rate [18][19].

We investigated the requirements engineering process in an open innovation context. The purpose was to 1) gauge how common OI is in the RE practice and to what extent it is implemented, 2) understand the impacts that OI enforces in the RE process by identifying the drivers and barriers of its implementation, and 3) find out if the implementation of OI actually leads to new innovation and if so, what kind of innovation. Additionally, we wanted to determine if there was an agreement between the practitioners and/or the different companies. That is, to what degrees do the practitioners, regarding their work and what they consider to be important, vary.

In order to investigate open innovation and its impacts in the requirements engineering practice, the following research questions were formulated:

- **RQ1**: How common is open innovation in the requirements engineering process?
- **RQ2**: What are the main drivers and barriers to open innovation in the requirements engineering process?
- **RQ3**: What kind of innovations, 'if exist', does the implementation of external requirements leads to?

3.1 Planning and Design

The on-line questionnaire was designed using a mix of open and close-ended questions [16][17]. The first version of the questionnaire was pilot tested using PhD students from the Department of Computer Science and Engineering at the University of Gothenburg. As the test was taking place, we monitored the time, and observed possible miss-understandings of the questions formulated. Based on the pilot, the survey instrument was improved. A second pilot test was achieved using a colleague from industry giving additional feedback on the instrument. The questionnaire was divided into three main parts in which each included a mixture of question types: single-choice, multiple-choice with check boxes, and multiple-choice with text boxes for free text. The reason behind using text boxes was to allow respondents to expand their answers [18].

The design of the questionnaire was mainly as follow (see Appendix):

a) Demographic data (what roles, years of experiences, etc.)
b) Understand the subject's beliefs about Open Innovation, how aware they are about the topic.
c) Understand what is the subjects' current process like, how OI is impacting their work at the company (both positive and negative).

The motivation of using on-line questionnaires was to maximize coverage and participation and also because of the tight schedule of some companies. In this case, companies could answer the survey whenever they felt for, of course during a limited period of time. Moreover, it helped to overcome the problems of getting time for interviews out of time and/or the risks of re-scheduling interview's meeting.

3.2 Data Collection

The data was collected through a structured self-administrative questionnaire, which was made accessible on-line within Google Forms between April 23th and May 8th. To answer the questionnaire took no longer than 15 minutes, however, judging that there were free-text responses a number of people may have spent even more time. The theoretical population in this study was any software practitioner with experience in using requirements engineering activities, e.g. elicitation, stakeholder analysis, specification, prioritization, release planning. The actual population was limited by the ability to contact software practitioners within the limited time of the study and the practitioners' willingness in participating in the study. Our sample, on the other hand,

can be described as convenient sampling [17] as the questionnaire was sent out to our supervisor's industrial network, and to our own local contacts. We finally reached out a total of 54 practitioners, in which a total of 35 answered the survey, giving a response rate of 67% of the population. The goal was to reach out companies in Sweden that were software-centric; this could include industries such as automotive, telecommunications and IT. We were interested in medium to large organizations, however since the practitioners were asked to spread it out, we could not make sure that our data only consists of medium to large firms.

3.3   Data Analysis

The analysis of the data was done through a descriptive statistic analysis. The results of the data are presented in Section 4. Most of the survey's questions (71%) were marked as compulsory; since all of the participants answered all the compulsory questions we report them as completed. With complete answer we mean the rows that are fully answered and with no "NA" as an answer. A total of 35 participants completed the compulsory questions. When analyzing the data collected, we were able to identify three types of population that enabled us to compare the results from the participants in a better way. In this case, the population identified were the different development process types, *Agile* (18 participants), *Plan-driven/agile-in-teams* (13 participants) and pure plan-driven (4 participants) (see Figure.5).
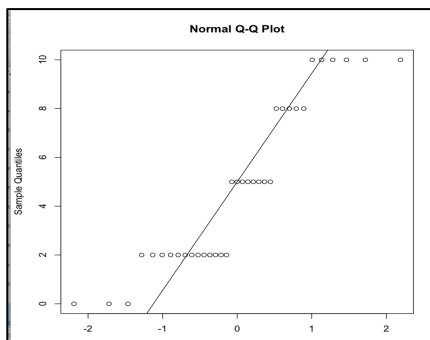

Q9. Would you consider Open Innovation's suppliers (ecosystem/open source/third-party) a generator of requirements for your company?

1. **Yes**
2. **No**
3. **Other, please specify:_____**

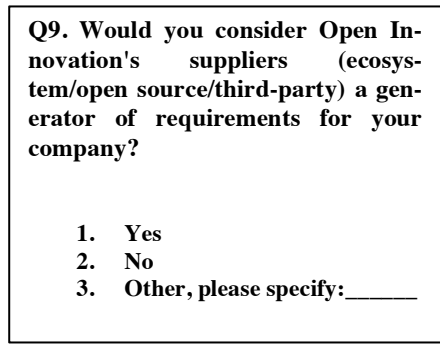**Figure 1.** QQ Plot (years of experience).   **Figure 2.** Q9 Survey Example.

Well-known techniques were used to analyze the data, for instance, by applying the QQ plot distribution test, we could check whether the data was normally distributed or not. This would allow us to understand the sampling distribution and select the most appropriated method to further compare our participants. As Figure 1 shows, the result of the data was not normal distributed and therefore we performed a non-parametric method for data analysis. Non-parametric is a not normal distributed statistic that makes no assumptions about the probability of the variables being evaluated [20][21]. It differs from the parametric model in that it does not involve estimation of key parameters of the distributions [20]. Also, non-parametric models are useful for

analyzing small sample sizes and are more accurate than t-test statistic in non-parametric tests [21].

If one follow the bullet points at the figure above (Figure 1), one can argue that there are lots of points going out the line, meaning that the data is not being distributed in a normal way. However, if all the points were better aligned we could have argued to used a parametric approach such as the t-test statistic, but since it is not the case, using a t-test statistic would not suit this data analysis. Thus, we made use of the Mann Whitney-Wilcoxon U Test [22]. We chose this type of test, because it was appropriated for examining the difference in medians for 2 independent populations. Since the population (e.g. Agile vs. Plan-driven/agile-in-teams, plan-driven vs. agile, and plan-driven vs. Plan-driven/agile-in-teams) was independent, this technique helped as a way of examining the relationship between a numeric outcome variable, e.g. the alternative answer in each question, and a categorical variable with two levels, e.g. Development approach.

The Mann Whitney U test evaluates that two populations are the same against an alternative hypothesis, where one of the population tends to have larger values than the other [22]. In non-normal distributions it is more efficient that the t-test statistic method [23]. To be able to perform this test, it is required a significant value called 'a', which is mostly stated as 0.07, 0.05 or 0.01. In this case, we keep the value 0.05 to compare the samplings. A 'p-value', on the other hand, is needed to hold the sampling and to determine if there is a relationship or not between the samples.

3.4 Validity Threats

In this study, we considered the four perspectives of validity threats presented in Wohlin et al. [24]. These are: *construct validity*, *conclusion validity*, *internal validity*, and *external validity*.

Construct validity: this type of validity is concerned to the theories behind the research. The variables in our research are measured through the survey, including close and open-ended questions where participants were asked to share their professional experiences. We collected data from different sources of the topic in study to avoid mono-operation bias. Complete anonymity of the subjects was guaranteed, which was stated at the beginning of the form. Another potential threat here is "hypothesis guessing", meaning that the respondents try to guess what the researchers want. Therefore, it was clearly stressed in the instructions of the survey, the importance of honesty, however this threat cannot be completely dismissed. There is always a risk that the background of the subjects (e.g. experience) is an essential influence, however, since the competence and level of experience is spread we considered that it partly limited the risk.

Conclusion validity: this is concerned with the possibility of incorrect conclusions that may arise from error sources such as, instrumental flaws, influence posed on the subjects, or selection. We cannot exclude the possibility that the instrumentation (survey questions, formulation and/or explanations) were misunderstood by the subjects, however, we conducted pre-tests with colleagues from the university and industry that hopefully helped to minimized the threat of retrieving wrong or missing crucial in-

formation. Regarding the influence the subject may get, for instance, when interacting with colleagues at the work place may unduly influence the result. However since it was distributed to different companies and different persons we believe that this threat was limited.

Internal validity: this threat is related to issues that may affect the causal relationship between treatment and outcome. Since the questionnaire took only 15 minutes; subject's responses could be influenced by boredom. However, the completion rate of respondents, where all the respondents finished the questionnaire, indicates an interest in participating in the survey. The interest of the subject may influence the representativeness of the subjects. This is a hard threat to counter, as willingness to participate and interest in the subject are associated. Participants were recruited primarily through personal contacts and via email, and encouraging those who participated to spread the word. We asked them to report back how many colleagues they sent the questionnaire to. In addition, another threat could be the language, as the questionnaire was done in English and we do not know what level of knowledge the participants had.

External validity: this threat is concerned with the ability to generalize the findings beyond the actual study. The actual setting of the study was an environment known to the subjects (from home/office using the web), thus our control and influence of the context was minimal. In order to generalize the findings we reach out as many companies as possible to face the risk of not gathering enough data. However, since the subject is relatively new it limited the risk of finding companies that use open innovation.

4   Results

In this section we present the results of the data collected from the survey. Since the background of the participants was also of importance we include it as a subsection, the remainder of this section is organized according to the research questions presented in Section 3. Our focus is, thus, on the survey's questions directly relevant to RQ1, RQ2 and RQ3 (see Section 3). As mentioned in the analysis, a total of 35 participants were able to complete the compulsory questions, therefore, we give full details of those questions we report on (see Appendix).

4.1   Participants Background

In the figure below (Figure 3), the results show that the most common role among the participants was *Product Manager* with '12' participants (34%). A second visible and common role, as showed in Figure 3, was *Product Owner* with '6' participants giving a total of 17% rate. In third place, we found '3' *Software architects* (8%), '3' *Chief architects* (8%) and '3' *Software engineers* (8%) as common roles; the rest is though spread in other different roles (see figure 3).

About 46% of the participants (16) claimed working with *Market-driven* project development (see Figure.4), and 37% with a *Mix of bespoke and Market-driven* pro-

ject development (13 participants. Another 9%, with a total of '3' participants, worked with *Bespoke* development projects and finally 6% (2 participants) worked with in-house project. Only 2% (1 participant) claimed working with all type of projects.
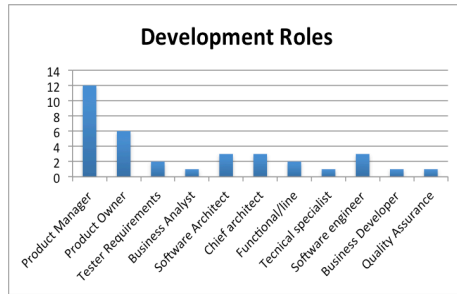

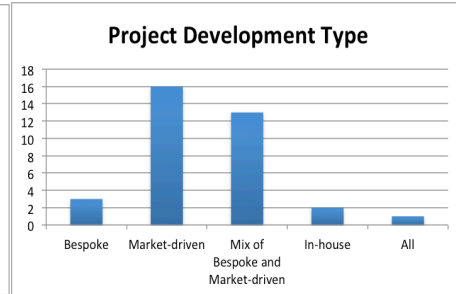**Figure 3.** Participants Roles

Figure 4. Participants project development type

Almost all the participants (77% with 27 participants) had at least some experience/awareness of *open innovation*, where 45% of those (12 participants) had at least between 1-3 years of experience in the requirements engineering process. However, the overall awareness/experience of the participants with open innovation practices was quite low, as 34% of the total participants answered that they had *little knowledge*. Only 43% of the participants claimed to have *medium* to *high* knowledge whith one (1) of them having excellent knowledge on the topic.

On the other hand, almost all the participants (91% with 32 participants) had at least some experience in the requirements engineering process, with most of them having 1-9 year of experience and 17% having more than 10 years of experience.
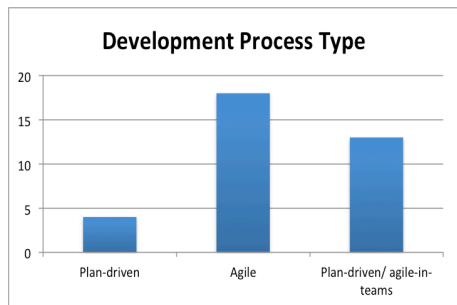

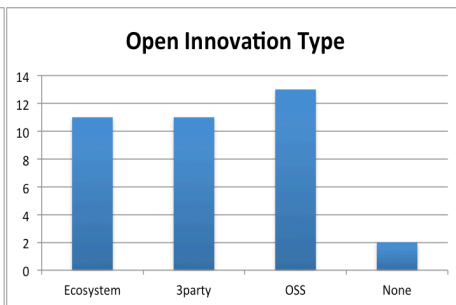**Figure 5.** Respondents development process

Figure 6. Respondents participation type

With respect to the development process (Figure.5), about 51% of the participants (18 participants) worked in *Agile* development process. Other 37% (13 participants) worked with *Plan-driven/agile-in-teams* development process (Figure.5), and 11% (4 participants) worked in pure *Plane-driven*. Here, we noted a relationship between the development process type and project development type, as 44% of participants (8 participants) in *Agile* development process worked with *a Mix of bespoke and Mar-*

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ket-driven development projects and 62% of the participants (8 participants) in *Plan-driven/agile-in-teams* development process worked with pure *Market-driven* projects. Additionally, this gives us that, approximately, 89% of the participants worked in some sort of agile development approach. Only 4 participants worked in a pure plan driven.

Furthermore, 29% of the participants (10 participants) have at least participated in *Ecosystem* open innovation type (see Figure.6), with 50% of those (5 participants) working with *agile* development process. About 37% of the participants (13 participants) have at least worked with *Open Source Software* type, where 31% of those worked in *agile*. Finally, 31% of the participants worked with *3party* OI type, where 41% of those worked in *agile* processes. Note that 2 participants from the *Plan-driven/agile-in-teams* stated that they worked both in OSS and 3party.

When asking the participants how they interpreted the concept of open innovation, 71% agreed that OI is "a way of sharing ideas" and "a way to collaborate with external actors". Thus, most of the participants had at least an idea of OI meaning. Another 19% of the participants commented that they had no idea about what OI really meant.

4.2   Open Innovation in the RE practice (RQ1)

To gauge how common open innovation is in the requirements engineering practice, we considered the following questions: Q8, Q9, Q11, Q12, Q13, Q14 and Q28 (see Appendix).

First, the results for Q8 shows that almost half of participants (49% with 17 participants) only participated *in some projects* (Q8:3) that involved open innovation practices, for all using any kind of development process. Another 14% (5 participants) claimed that they participated *in most projects* (Q8:4) and 23% (8 participants) participated *seldom* (Q8:1) in OI projects. We performed the Mann Whitney U test [22] to see the difference in medians between the different development process types (note that we will always refer first to the relation between the agile and the plan-driven/agile-in-teams participants and then the pure plan-driven with the already two mentioned). Since the 'p' value for the first two samplings is 0.9088 and not less than 0.05 (the value we use to compare), then there is no significant value that states that participants using agile process participate more often, in *open innovation projects,* than participants using plan-driven/agile-in-teams. Since there was no difference here, we performed a new test with the pure plan-driven and agile participants and plan-driven with plan-driven/agile-in-teams, to see if there was any relation. The p-value here is 0.6038, thus, there is no sufficient difference either with the plan driven participants.

For Q9 the results shows that most of the participants (71% with 25 participants) considered open innovation's suppliers, such as Ecosystems, Open Source Software and 3party, 'a potential generator of the requirements' in their company, no matter what type of software development process they where using. Also here, the 'p' value (0.6894) is not less than 0.05, therefore, there is no sufficient significant evidence to say that participants from *agile* development process consider more open innovation suppliers requirements than the plan-driven/agile-in-teams participants. For the plan-

driven participants, on the other hand, half of them do not considered open innovation's supplier a potential generator of their requirements. However, we noticed that 8 participants (23%) considered ecosystem a potential supplier for their requirements (Figure.7), other (10) participants considered Open Source Software a potential generator of their requirements (29% participants), and (6) participants considered 3party a potential generator of their requirements (about 17% of participants). The other 31% of the participants do not considered suppliers as a potential generator of their requirements.
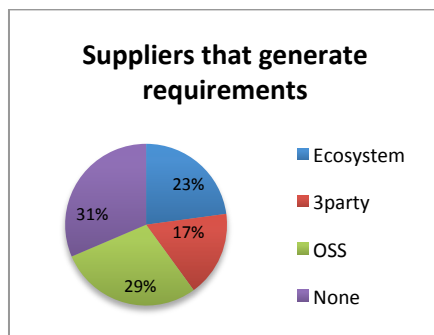

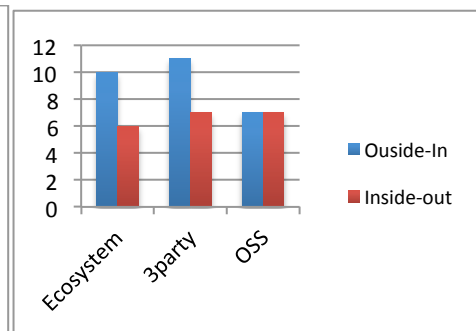**Figure 7.** Suppliers that generates most requirements among the participants.

Figure 8 OI - Outside-in vs. Inside-out

Yet again, for Q11, almost all the participants (86% with 30 participants), regardless the development process, agreed in receiving ideas/requirements/features from external actors. Because the value of 'p' is 0.5837 between agile and plan-driven/agile-in-teams, then, there is no sufficient evidence to claim the opposite. Also for the plan driven participants there is no sufficient value (note that we always compare the pure plan-driven participants with both agile and plan-driven/agile-in-teams). Nonetheless, more than half (54%) of the participants (19) agreed in that they only *sometimes* received ideas/requirements/features from external actors (Q12).

Further, 71% of the participants (25 participants) managed the internal and external requirements (Q13) in the same way and most of them claimed that there was no difference in between. The remainder 29% did not now how they managed. For Q14, big part of the participants (22/35) agreed that when selecting potential requirements, they prioritized ideas that are from 'both' internal and external sources. On the other hand, 26% of the participants (9) agreed that their companies, *very seldom* (Q28), provided external actors with ideas/requirements/features, 29% (10 participants) *sometimes* provided external actors with ideas/requirements/features, and 11% (4 participants) provided *often*. This gives at least a 66% of the participants providing, somehow, external actors with ideas/requirements/features. We performed, the Mann Whitney U test [22] but since the 'p' value was larger than 0.05 there was no significant value to claim the opposite. For the pure plan-drive participants we found that only for Q28 they differ in their answer against the other participants with different development process. Here, participants from the plan-driven development process chose frequently the alternative 'sometimes' while other chose 'very seldom'.

We also compared the participants using *outside-in* (receiving innovation) and *inside-out* (providing innovation) approaches regarding the open innovation type. The results shows that 10 of the participants that participated in ecosystems (OI) used the outside-in approach (note that this is 90% of the ecosystem participants, see figure 8) and only 6 participants use the *inside-out,* thus, 6 of them use both *outside-in* and *inside-out* approaches. From the 3party perspective, 11 of the participants (100%) used *outside-in* approach and 7 participants used the *inside-out*, giving 64% of the participant using both approaches (7 participants). Finally, 7 participants that participated in OSS open innovation type used both *outside-in* and *inside-out.* This gives a 54% of the total participants in OSS (see Figure 8). If we put all the OI type (Ecosystem, OSS, 3party) together we get that more than half (65%) of the participants use both *outside-in* and *inside-out* approaches at the same time.

In summary, 49% of the participants participate in *some projects* that include OI practices, 71% of the participants considered open innovation's suppliers a generator of their requirements, 86% of the participants agreed that they received ideas/requirements/features from external actors, 54% only sometimes received ideas/requirements/features from external actors, 71% of the participants managed the internal and external requirements in the same way, 63% of the participants prioritized ideas from both internal and external sources, and 29% of the participants provided *sometimes* external actors with ideas/requirements/features. Finally, 6 participants in ecosystems, 7 participants in 3party and 7 participants in OSS used both *outside-in* and *inside-out* approaches of OI.

4.3   Drivers and Barriers to Open Innovation in RE (RQ2)

For RQ2 we wanted to identify the drivers and barriers to open innovation practices in the requirements engineering process at software organizations. To answer this research question we considered of importance Q16, Q19, Q20, Q21, Q24, Q25, Q26 and Q27 (see Appendix).
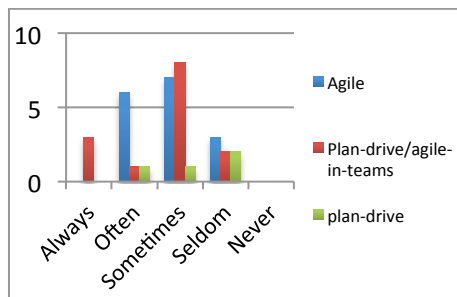

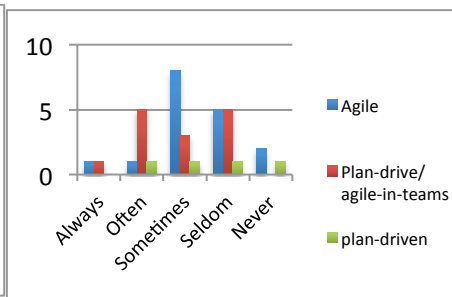**Figure.9** Costumer benefit frequency rate   **Figure.**10 Shortened time to market benefit rate

For Q16, the results shows that almost half of the participants (46%, 16/35 participants), regardless their development process, agreed in that implementing requirements from open innovation, only *sometimes* (Q16:3), provided higher costumer ben-

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efits (Figure.9). 17% participants (6/35) agreed that it *very often* (Q16:2) provided higher costumer benefits and 26% (9/35 participants) answered *very seldom* (Q16:4).

Regarding Q19, 37% of the participants (13/35) agreed that their companies were more *neutral* towards Open Innovation. Another 29% were *rather positive* towards it (10 participants). Only 14% (5 participants) were more *positively* towards it. We performed the Mann Whitney U test [22], since the 'p' value is (0.854) larger than 0.05, then there is no sufficient evidence to state that participants using *agile* development approach are more positive towards OI than participants using *plan-driven/agile-in-teams*. The same implies for participants from the pure plan-driven, as the p-value 0.4629.

The major drivers to open innovation mentioned among the participants are (Q20): possible new generated ideas, with 40% of the participants (14/35), Cost effectiveness 17% (6/35), costumer benefits with 20% of participants (7/35), 6% cooperation (2/35), and improvements 11% (4/35). We also found some negative aspects. 77% of the participants (27/35) believed that open up to much face the risk of *loosing ideas* to competitors, as they cannot 'protect keys ideas' (Q21). 20% claimed that the amount of new ideas/requirements is not enough and sometimes not useful. Another 37% (13/35) demanded that lack of knowledge is one of the main concerns to the use of OI (Q22). 3% of the participants mentioned cost investment as a barrier, as licensing and researching where important parts in this area (Q21). 34% (12/35) encountered it hard to find the right partner, which made them a bit concern about how to protect their ideas (Q22). However, the data show that most of the participant still use or at least have used open innovation.

On the other hand, 74% (26/35) of the participants agreed that the inclusion of OI requirements do not hinder or threaten the creation of the product, but it does to their ideas, as they cannot protect them (Q24). Most of the participants agreed that open innovations practices do not impact (Q25), in either positive or negative way, rather it is neutral towards the requirements engineering challenges, such as *identifying stakeholders' needs*, *Changing requirements, Quality requirements, Requirements prioritization, Requirements overload, Requirements traceability, Communication*. However, 43% of the participants (15/35) claimed that *identifying stakeholders' needs* was challenging and somehow it impacted it rather negatively (Q25.1:2), 34% of the participants (12/35) thought that *Changing requirements* was not challenging and its impact more was *positively*. 26% of the participants (9/35) believed that OI impacted *Quality requirements* positively. 34% participants (12/35) believed that it impacted it *rather negatively* to the *Requirements prioritization*. 40% (14/35) agreed that it impacted the *Requirements overload rather negatively*. 34% (12/35) agreed that it impacted it the *Requirements traceability rather negatively*. Finally, 29% (10/35) believed that it impacted *Communication* in a *positively* way.

Regarding Q26, most of the participants agreed that *sometimes* (Q26:3) the implementation of external requirements helped to shortened the time to market of a product (Figure.10), and *very seldom* (Q27:4) helped to increase the quality of the product. We performed the Mann Whitney U test [22], since the 'p' value is (0.5874) larger than 0.05, then there is no sufficient evidence to state that participants using *agile* development differ from *plan-driven/agile-in-teams* participants.

In summary, 46% of the participants agreed that implementing external requirements only *sometimes* provided higher costumer benefits, 37% of the participants agreed that their companies were more *neutral* towards Open Innovation. The most common drivers to open innovation mentioned among participants were: new generated ideas, cost effectiveness, costumer benefits and cooperation. Barriers to open innovation mentioned among participants were: Loosing ideas, not enough useful ideas, lack of knowledge, cost investment, and hard to find the right partner. 74% of the participants agreed that the inclusion of OI requirements do not hinder or threaten the creation of the product. Most of the participants agreed that *sometimes* the implementation of external requirements helped to shortened the time to market of a product and *very seldom* helped to increase the quality of the product.

4.4 Innovativeness (RQ3)

For this research question, we wanted to identify if the inclusion of external requirements helped organizations be more innovative. Additionally, we wanted to find out what kind of innovation these external ideas may lead to. Thus, we considered of importance Q10, Q15, Q17 and Q18 from the survey (see Appendix).

The results showed that 57% of the participants (20/35) agreed in that, their organizations measured, somewhat, the *innovativeness* (Q10) of the ideas/requirements/features that were elicited from the ecosystem/open-source/third-party supplier. Another 43% of the participants answered that they did not measure the innovativeness. We also asked the participants to describe in what way they measured this innovativeness (Q10.1), since it was a follow up question to Q10, and was not marked as compulsory, only 46% of the participants answered this question. 67% of those participants answered that they measured the improvements and/or number of ideas generated by the idea obtained from the supplier. We conducted the Mann Whitney U test [22], since the 'p' value is (0.611) larger than 0.05, there is no evidence to claim that the groups differ. We did not find any sufficient evidence to claim the opposite for the plan-driven participants either. That is, all participants agreed on their answer.
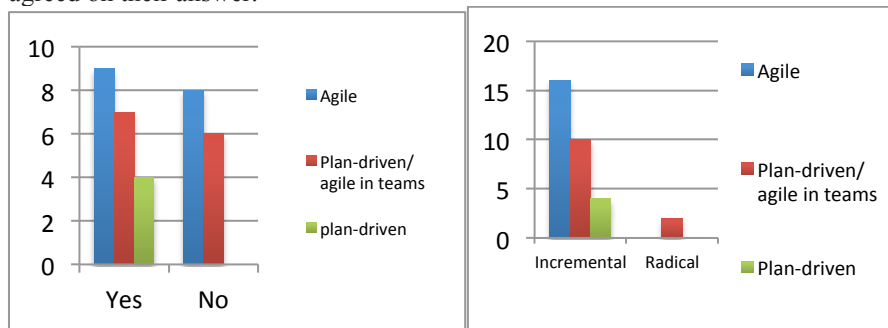

Figure 11. Measurement of Innovativeness   **Figure. 12** Innovation type among participants

Furthermore, most of the participants (89% 31/35) agreed that the inclusion of requirements from external actors mostly lead to *incremental innovation* (Q11.1:1),

rather than *radical innovation* (6%, 2/35, see figure 12) (Q11.1:2). Hence, 89% of the participants claimed that the implementation of external ideas/requirements/features (OI) helped to develop new features/products/innovations (Q15). However, 70% of those participants, stated that only 'sometimes' (Q15:3) external requirements helped them to develop new features/products.

When asking the participants how often the implementation of external requirements led to 'new innovation', half of the participants (46%) answered that it 'very seldom' (Q17.4) led to 'new innovation'. Only 43% believed that it led 'sometimes' (Q17.3) to new innovation. A similar question were asked to the participants where 57% agreed that implementing ideas/features/requirements from external sources 'very seldom' and almost 'never' led to radical innovation (Q18).

5   Discussion

In this section we discuss the results presented in the section above and it is organized in the same order. The main focus of our discussion is directed to participants using Agile and Plan-driven/agile-in-teams development process, however we include the participants from pure plan-driven process as it still have relevant aspects that should be taken in consideration. These aspects and the background of the participants will lay the foundation for further reasoning of our analysis. Here, we also reflect on our observations of the questionnaire and how it could have affected the data and the results of this study.

5.1   Open Innovation in the RE (RQ1)

Regarding RQ1, on how common open innovation is in the RE process, our analysis shows that there is general, but by no means universal, common experiences among the participants regardless their development process e.g. receiving ideas from external actors. Even though there are some variations among the participants in e.g. how extensively they use OI, there is no big difference between the participants using different development process. On the other hand, since the questionnaire was done online, we cannot make sure that the participants did not mixed the concepts of open innovation and open source software, as this is a common problem found in literature [1][5][6]. In overall, when asking the participants about the concept of OI, some participants made assumptions and even wrote that open innovation was still a confusing subject. This is not completely surprising because most of the participants' background showed little knowledge about the topic. These can also relate back to literature, as lack of knowledge is one of the main issues mentioned [1][3]. However, most of the participants asserted a small idea of the concept. We still feel confident with the results obtained as the level of experience in the requirements engineering practice was spread and of high quality among the participants.

While little knowledge of the topic was discovered, we found it surprising that most of the participants only participated *in some projects* that included OI, as most of them claimed that external suppliers, such as Ecosystem, OSS and 3party, were 'a potential generator' of their requirements and 87% of them received, somehow, ideas

from external sources. This may be due to that participants believed that open up to the outside face the risk of loosing their ideas to competitors. Some researchers [1][3][6] have encountered that, for instance, adopting an open source platform may not be a matter of choice, because competitors may attempt to take competitive advantage via the platform and, that sometimes, the market value of the innovation could be limited by the fact that competitors may be using the same open source solution as the company. Another fact to this issue could be the lack of knowledge about which methods and tools to use for full exploitation of OI. This is in line with what several researchers [2][3][5] have found in literature, the deficiencies of research in the field so that other researchers and organizations can benefit from its capabilities. All these could also be the reason to that most of the participants only 'sometimes' receive ideas from external actors, as they do not open up themselves as often as they should.

On the other hand, since we notice that our participants had different roles, this may have affected their response regarding the prioritizations of the requirements from internal and external sources. However, since most of the participants claimed to have experience with the requirements engineering process, we felt secure with the result. Here, most of the participants agreed that they managed and prioritized both internal and external requirements in the same way and even claimed that there was not difference in between. This is not exactly surprising. But the reason they do so may be due to that organizations do not focus or put enough time and weight in identifying and implementing the most rewarding and appropriated functionality, to fulfill customers' needs and expectations. As reported by Karlsson et al. [11], organizations unfortunately tend to underestimate this task, as during the software engineering process, requirements are often considered equally important and not ranked or prioritized with a value. We suggest, however, that organizations should make use of existing techniques that can help them to find the most suitable and profitable requirements that are more aligned with the current business model of the company, so that the generated ideas of the implemented requirement can benefit organizations in a better way, providing more growth opportunities.

We found it interesting, however, that 65% of the participants claimed to work with both outside-in and inside-out approaches. This is a quite high rate as according to some researchers [1][5], by now there is no single organization working on pure OI. Even though companies are using both approaches (outside-in and inside-out) we still cannot claim that they use the coupled technique mentioned by Enkel et al [3] because the results does not show the importance of the give and receive in order to commercialize innovation. However, from one perspective, we can conclude that OI practices are becoming more and more fully exploited from both the outside and inside.

To conclude with our RQ1, our results show that there are several common experiences among the participants regarding OI in the RE, e.g. receiving from and providing to external actors ideas/features/requirements. It is important to highlight that OI is useful in most kind of development process and project types, e.g. agile, plandriven/agile-in-teams and even pure plan-driven. Therefore, we encourage organizations to experiment with the capabilities that OI can offer. There are many different ways to make use of the OI paradigm, by different mechanisms (Ecosystem, OSS, 3party). However, we see the need for introducing new or adapt existing techniques

for managing innovative feature concepts, from both the inside and outside, since there is clearly a lack of knowledge of the topic. Techniques to better identify innovations that come from external actors and that can be helpful to align the generated innovations with the overall business model and product portfolio of the company.

5.2   Drivers and barriers to OI in RE (RQ2)

About the drivers and barriers to OI in the RE (RQ2), we found that 71% in total agreed that implementing requirements from external actors brings higher benefit to the costumers. This was mentioned as a potential driver to open innovation among the participants. Other drivers mentioned, such as new generated ideas, cost effectiveness, cooperation and improvements may also help to capture the attention of new organizations towards OI. By highlighting the advantages of e.g. the capabilities that OSS or a software ecosystem offers [5], makes it easier to foster the concepts of OI. It was surprising that only 9 participants stated that their companies were *rather positive* towards OI, when most of them claimed to use OI practices and that some of the main drivers mentioned were generated ideas and rewarding. This might be due to the barriers such as loss of control and ideas, hard to find a good partner, and most probably due to cost investment. Some researchers [1][3] mentioned that early or frequent contributions create a risk of losing competitive advantage while late or rare contributions can greatly increase the maintenance cost.

We find it, however, contradicting that cost effectiveness and cost investment are both mentioned as a driver and barriers. We believe that this may be because implementing external requirements somehow help to decrease the cost of implementation and time to generate own internal innovation, but since there is still a lack of knowledge of OI, organizations must put time and research investments to better gain profitable advantages with the use of OI [3]. Since we do not know how much thought the participants put in the questions, we cannot figure out if there were other important drivers and barriers to OI that participants may have wanted to mention, but that they may have forgotten. Additionally, people may read different into each question and therefore answer based on their own interpretation of the question, e.g. what it is 'good' to someone may be 'poor' to someone else.

That most of the participants agreed in that the inclusion of OI requirements do not hinder or threaten the creation of the product, but to their ideas, it is not surprising. This was also shown in Enkel et al [2] study. Nonetheless, this could be due that it is hard to protect organization's potential generated ideas, since other competitors may be e.g. using the same open source solution as the company [1]. Here, the product itself might be achieved but the risk that other organizations may be faster in bringing to the market similar products as the company is quite big. Organizations and even researchers should find a way to help organizations to protect the ideas generated by the OI practice and to make good use of them.

Further, our analysis suggests that challenges in the RE, such as changing requirements, quality requirements and communication are not impacted by open innovation practices, its impact is mostly rather positively than negatively, which may make it more manageable to organizations. Identifying stakeholders' needs, requirements prioritization and requirements traceability are, on the other hand, impacted more rather negatively than positively. Making it though more challenging to organizations,

for instance to identify possible innovations that are aligned with the overall business model of the company [9][11]. Since organizations do not put time on identifying and prioritizing the incoming requirements, we encourage researchers to find new or adapt existing methods and techniques for identifying and prioritizing requirements that are more suitable for the open innovation context, and to find the balance between limited and generous contribution strategies, in order to help organizations benefit from OI capabilities.

To conclude with our RQ2, our results suggest that there exist potential drivers and barriers to open innovation. The drivers clearly show big impacts in improving the own internal organization knowledge (such as new generated ideas) and also giving higher costumer benefits. This may be good enough to inspire organizations to open up themselves and use more often OI practices. However, some of the barriers are also important to take in consideration so that organizations have it easier to implement OI practices.

5.3   Innovativeness (RQ3)

Our RQ3, about what kind of innovation, if exist, does the implementations of external requirements lead to, shows that most of the participants agree that the implementation of external requirements help to develop new features, ideas and/or requirements. This was an expected answer as according to Chesbrough [6] the main goal of OI is to generate profit and growth. However, we were quite surprised that, when it comes to measurement, only 52% of the participants claimed that their organizations measured the innovativeness of the ideas generated. The way participants measured innovativeness was interesting as there was no single technique mentioned among the participants to clearly specify innovativeness, only counting the generated ideas is not sufficient. According to Edison et al [2], innovation measurement initiatives assess innovation capability, output and performance to help develop understanding and control of the activities and determinant of innovation. We do not know exactly in what circumstances do the participants measure innovativeness, when or why. Some of the participants answered that it was a private method and therefore they did not wanted to share an explanation. However, we assume that one of the reasons to that organizations do not measure innovativeness could the fact that participants' lacks knowledge about tools and techniques for the exploitation of OI practices, which was one of the barriers mentioned among participants. This is an important issue to organizations to really understand the incoming innovations and the generated ideas.

Something that we found it surprising was that the most common kind of innovation among the participants was *incremental* innovation, as (83%) of the participants agreed on that. This makes us to think, why it does not lead to radical innovation? As found in the literature, the streaming of external ideas may also lead to disruptive or radical innovation, that most likely is coexisting with incremental innovation [3][2]. The results show clearly that 'very seldom' the implementation of external ideas help to create features that introduce exceptional performance. Yet again, we do not know if the participants were thoughtful about this question, and thus the result cannot explicitly tell us the meaning of the response. However, we noticed during the analysis that participants could only choose one of the alternatives in the questionnaire. This may have though implicated the response of the participants, nonetheless a third

choice was allowed which was made open and participants could have answered something different.

When reflecting on our results in innovativeness, we also realized that the implementation of OI in the RE is also related to the different kind of innovations mentioned in literature [2] [3] [14]. For instance, the incremental innovation revealed in this study relates to the 'product innovation', OSS communities, Ecosystem and 3party relate to 'process development' and the use and implementation of OI practices relates to 'organizational innovation'.

We conclude with RQ3, that there is a big possibility that the implementation of external requirements help to develop new features/ideas/requirements. The capabilities of OI help to continuously improving solutions to create more value in organizations' products and services (incremental) as mentioned by the participants. Since most of the participants are benefiting from OI innovation practice, we invite more organizations to use and experiment OI alternatives. We believe still that there is a need of adopting new or existing techniques to measure the innovativeness of the ideas generated, in order to help organizations make use of the generated innovations and not loose them.

5.4 Limitations

When reviewing the literature some authors [5], suggested as future work regarding open innovation, the following directions: software processes, analysis of requirement engineering, software design, software development, and testing. However, due to limited time of this research, this was not feasible and therefore we decided to only focus on the requirements engineering aspects. After conducting the data analysis and reflecting on our finding we noticed several things that could be done to improve the study even more. Because we wanted to narrow down the questionnaire to be short and concise, and to guarantee the anonymity of the respondents, we decided to leave out some questions regarding the background of the company, such as, name, size, branch, etc. This allowed many participants to respond our questionnaire. Since the purpose was to gauge common experiences of OI in the RE, identify barriers and drivers, and the innovativeness of the use of OI, we thought that the missing factors were not the major objectives of this study. In addition, we realized that expanding our knowledge by digging in more in the literature and having more time to get response to the questionnaire would have improved this study, as having more participants broader understanding the problems of the topic and make the results more powerful. The actual population was limited by the ability to contact software practitioners within the limited time of the study and the practitioners' willingness in participating in the study. We still believe that questionnaires are an appropriate strategy to easy summarize, compare, and generalize a sample data [17]. Nonetheless, one of the main problems we encountered with the questionnaire was the inability of making follow up questions. After the questionnaire was sent out we noticed that we could have made other questions that we might have ignored in the very beginning.

6 Conclusion

This paper presents the results of an empirical study that examine the use of OI in the requirement engineering practice. Such use, include common experiences, barriers and drivers to implementation and measurement of innovativeness that the practice in the RE may enforce. We carried out our study through an on-line survey, to which results are the main contribution to the study. The results obtained from the survey emphasize the use of OI between the different development processes and project types. Our results reveal that receiving from and providing to external actors with ideas/features/requirements is common and widely done amongst participants. 68% of the participants made used of both inside-out and outside-in approaches of OI. Nonetheless, implementing requirements in an open innovation context can be challenging, as requirements and implementation are freely available for several potentially contributing organizations. Potential drivers to OI in the RE such as new generated ideas, cost effectiveness and higher costumer benefit are only some of the drivers, mentioned among the participants. Barriers such as fear of loosing ideas to competitors and finding the right partner are also revealed in this study. However, the results still show that there is a big possibility that the implementation of external requirements help to continuously improving solutions to create more value to organizations' products and services (e.g. incremental innovation). We can though conclude that even that OI can be challenging in the RE it still shows good growth opportunities.

We suggest that future work should include further in-depth studies in understanding the impact of open innovation on requirements engineering processes, tools and techniques for full exploitation of OI, especially in finding a way to protect organizations generate ideas. Also, the focus should be on exploring new or existing ways of prioritizing requirements that could potentially be more suitable for the open innovation context. Another focus should be adopting new or existing measurements techniques to innovativeness, to make use of the generated ideas so that organizations do not lose them.

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Appendix

Q1.   What is your main role at the company?

Q2.   How many years of experience do you have working with Requirements Engineering?

Q3.   Which type of projects does your company participate in?

Q4.   Which type of development process does your company use?

Q5.   In a scale from 1 to 5 how familiar are you with Open Innovation?

Q6.   Describe what is Open Innovation for you?

Q7.   What kind of open innovation do you participate in?

Q8.   How often do you participate in Open Innovation during work time?

Q9.   Would you consider Open Innovation's suppliers (ecosystem/open source/third-party) a generator of requirements for your company?

Q10.   Do you measure the innovativeness of the ideas/features/requirements that have been elicited from the ecosystem/open source/third-party supplier?

Q10.1   How do you measure innovativeness?

Q11.   Do you receive ideas/features/requirements from outside of your organisation?

Q11.1   If yes, how would you classify these ideas/features/requirements?

Q12.   How often do you receive ideas/features/requirements from outside of your organisation?

Q13.   How does your organisation manage internal (CI) and external (OI) requirements?

Q14.   When selecting the requirements in a project do you prioritize ideas/requirements.

Q15.   How often has the implementation of external ideas/requirements/features (OI) helped to develop new features/products/innovations?

Q16.   How often has the implementation/use of external requirements (OI) helped to provide higher customer benefits?

Q17.   How often has the implementation of external (OI) requirements lead to 'new innovation'?

Q18.   How often has the implementation of external ideas/features/requirements (OI) helped in the creation and introduction of new products different from existing ones?

Q19.   Would you consider your company positive or negative towards including requirements/ideas/features from open innovation/open source?

Q20.   What are the major drivers to open innovation in your company?

Q21.   From your own perspective, what are the major barriers to open innovation in your company?

Q22.   What prevents your company of using OI?

Q24.   Do you believe that being too open may threaten the creation of the product?

Q25.   How do you think open innovation impacts the following requirements engineering challenges and in what way:

1. Identify stakeholders' needs
2. Changing requirements
3. Quality requirements
4. Requirements prioritization
5. Requirements overload
6. Requirements traceability
7. Communication

Q26.   How often has the implementation of external ideas (OI) helped to shorten the time to market of a product?

Q27.   How often did the implementation of OI requirements/ideas help to increase the quality of a product?

Q28.   How often does your organisation provide external actors/companies with ideas/features/ requirements?