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Employees as contributors of self-developed solutions

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Abstract

We take a novel approach to analysis of idea management systems (IMS) based on the extent of innovation proposal's development and user innovation perspective. We analyze innovation proposals submitted by employees of a large information and communication technology firm to an IMS, taking into account characteristics of the innovation proposals, author, and the environment where proposals originated. We find that 6% of 759 proposals are employee-user proposals, and most of them are self-developed solution that is in use prior to submission. We find the employee user-proposals much more likely to be adopted within the firm, and to have a greater impact on existing processes, services, and products, compared to other innovation proposals. We discuss the implications of these findings.

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Employees as contributors of self-developed solutions

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Abstract

We take a novel approach to analysis of idea management systems (IMS) based on the extent of innovation proposal's development and user innovation perspective. We analyze innovation proposals submitted by employees of a large information and communication technology firm to an IMS, taking into account characteristics of the innovation proposals, author, and the environment where proposals originated. We find that 6% of 759 proposals are employee-user proposals, and most of them are self-developed solution that is in use prior to submission. We find the employee user-proposals much more likely to be adopted within the firm, and to have a greater impact on existing processes, services, and products, compared to other innovation proposals. We discuss the implications of these findings.

Keywords: idea management systems; employee involvement; employee-user innovation; innovation management.

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Introduction

Research shows that employees with promising ideas often lack the channels and motivation to communicate them (Burt, 2004; van Dijk & van den Ende, 2002). Idea management systems (IMS), or employee suggestion programs, are a popular response to the need to involve employees in innovation processes (Therrien & Léonard, 2003). However, the evidence of their success is mixed (Hastings, 2011; Tucker & Singer, 2012). While academic researcher of innovation thoroughly explored predictors of generating ideas and their submission to suggestion systems (Frese, Teng, & Wijnen, 1999; Ohly, Sonnentag, & Pluntke, 2006; Oldham & Cummings, 1996), implementation (Axtell et al., 2000; Kijkuit & Ende, 2010; van Dijk & van den Ende, 2002) and, improving odds for the ideas implementation (Baer, 2012), to our knowledge, no previous research explored the contributions by employees to an IMS from perspective of user innovation and the extent of the ideas development. In particular, we empirically investigate the performance of the innovation proposals submitted to the IMS, taking into consideration factors related to the innovation proposals, authors, and the environment in which the ideas generated.

The importance of considering the level of development of ideas before submission to an IMS and the user innovation perspective comes from the increase in the number of technology-savvy employees, need for efficient management of idea evaluation processes (Baer, 2012; Tucker & Singer, 2012; van Dijk & van den Ende, 2002), and technology that enables collaboration and distributed innovation (Baldwin & Von Hippel, 2011; Utterback, 2012).

The technology-savvy employees want their job done, and do not necessarily wait for the organizational bureaucracy to work out and provide a solution to a need they identified - they self-develop solutions (Dyche, 2012). Such a behavior is not new. Galbraith (1982) mentions an employee of a manufacturer of text editors who self-developed a programmability feature before the manufacturer's R&D lab, as he needed to program it for his own use. What is new, and worth of attention in the context of this research, is the immense set of software tools and knowledge publicly available at almost no cost (online), and the number of educated individuals who can make use of them.

The need for efficient management of idea evaluation process arises from the trade-off between positive effects of the high volume of sourced ideas (Girotra, Terwiesch, & Ulrich, 2010), and

costs of their evaluation (Toubia, 2006). Improper management of the evaluation processes may lead to a failure of idea management systems to attract contribution from employees (Van Dijk & Van den Ende, 2002), but the returns on investment in maintaining the system, in terms of the quality of the contributions, may discourage both the individuals in charge for evaluation for investing efforts, and the firm for keeping the system running (Toubia, 2006; Tucker & Singer, 2012; van Dijk & van den Ende, 2002).

With development of web 2.0 tools[1], firms have a chance to reduce potential bureaucratic inertia, and shorten communication lines among employees. Learning from the experiences from the open and user innovation community may contribute overcoming challenges that come with implementation of Enterprise 2.0[2], and actual employee participation (Denyer, Parry, & Flowers, 2011). A number of large firms are creating collaborative ecosystems for employees to engage into interactions, help each other, share knowledge and expertise, and collaborate in innovation. Collaborative social network for employees are a rising trend among large firms, tapping on innovation potentials of thousands of employees (Meister, 2011; Utterback, 2012). In addition, distributed open and user innovation seams to play an increasingly important role in the market (Baldwin & Von Hippel, 2011). A better understanding of how user innovations emerge inside the firm may help guiding efforts to increase productive interactions in such collaborative environments, as well as to obtain more accurate estimates of the research efforts at a firm-level.

The dissatisfaction with the existing solutions, sticky information, impatience to wait for the manufacturer of products, or in the organizational context – the bureaucracy, to respond to the emerging needs, and experimentation with self-developed solution are all properties associated with user innovators (Urban & Von Hippel, 1988; Eric von Hippel, 1986, 1994). These properties can also be extended to the organizational context, and associated with what we refer to in this paper as employee-user innovators. In fact, employees are not only the executors of tasks delegated to them, but also an internal user-community of firms' business processes, tools and products for internal use or for the market. So far, the user innovation research was focused

[1] "Web 2.0" is a introduced to denote development of the world wide web as a system for "harnessing collective intelligence" (O'Reilly & Battelle, 2009), where users are creating, exchanging, and developing content, as opposed to early "prototype" web where the content was being served to users as static pages in internet browsers (DiNucci, 1999). Web 2.0 includes social platforms such are YouTube, Facebook, or Twitter.

[2] Andrew McAfee coined the term "Enterprise 2.0" to label those digital platforms for "generating, sharing and refining information" that "… companies can buy or build in order to make visible the practices and outputs of their knowledge workers"(McAfee, 2006).

on two types of users, “intermediate users, who use the products as inputs to their own production processes, or end-consumer users, who use the products to satisfy their personal needs.” (Bogers, Afuah, & Bastian, 2010: p. 857). Using traditional value model system terminology (Bogers et al., 2010), the conceptual distinction between employee-user innovators and the existing user innovation research is that the employee-user innovators are employees in the industry firm, and their employee-user innovations remain in the domain of their employer. This paper provides a systematic assessment of the role of employees-user innovators, and the extent of development of employees’ innovation proposals in a large international firm that develops and sells products and services based on information and communication technologies. To understand the innovators’ role, we study innovation proposals (suggestions) submitted by employees to the firm's IMS. We begin by assessing if, among the innovation proposals, some describe employee-user innovations, with evidence that the proposal has been materialized with a self-use purpose. We then look at the universe of innovation proposals in the IMS and examine their performance, taking into account properties of the ideas proposed, the authors, and the environment, focusing on exploring the significance of employee-user innovations. We further explore the level of development of the proposals, and its impact on the adoption of the innovation proposals.

EMPLOYEES SELF-DEVELOPING SOLUTIONS: HYPOTHESES

We define the term “employee-user innovator” to refer to employees who innovate – self-develop solution inside a firm with the ultimate objective of benefiting from using their innovations, and not with the objective of having their employer broadly adopting or commercializing the innovations. We refer to the proposals they submit and describe the use objective as “employee-user proposals” (EUP), and to all other innovation proposals as “employee-non-user proposals” (ENUP).

The user innovation literature includes many examples in which individual users and user firms exhibit such behavior, innovating with the objective of benefiting from the use of their innovations rather than commercializing them (de Jong & von Hippel 2009; Enos 1962; Oliveira & von Hippel 2011; von Hippel 2010). These innovations are rooted in the employees’ use experiences from using or working with the products, or services, inside and outside the firms.

Given that many users are motivated to engage in modifying and creating products and services work with at their workplace or in their households (von Hippel 2010; von Hippel et al. 2010), it is very likely that some employees inside the firm also innovate for their own benefit. Such activities are relevant only if there is a value beyond the immediate need of one individual. In the context of the IMS, this relevance translates into broad adoption and implementation of the innovation proposals. Two properties of user innovations are particularly important when considering innovation proposals in the context of an IMS. One is that users who develop a prototype, or some functional modification of a product they use, tend to accurately articulate their needs and ideas (von Hippel 1988). The second is the success factor, as new products developed from user innovators' ideas are likely to be very successful (Lilien et al. 2002).

The articulation problem in formulating innovation proposals arises with the use experience and accumulation of tacit knowledge about needs and possible solutions. The tacit information that individuals hold is often "sticky"- costly to transfer (von Hippel 1994). Articulating ideas in the form of an innovation proposal may be a problem in a case of high stickiness. This problem can be solved by having users develop a solution for their own needs. Employee-users can combine their rich use experience and the availability of technological expertise to build sophisticated solutions to problems they face using business processes, products and services from the corporate portfolio. Once employee-user innovators solve a problem for themselves, they are likely to better characterize the problem they just solved - that is, to articulate their thoughts and ideas as an innovation proposal in the IMS.

Hence, our first hypothesis is:

> *H1a: Employee-user proposals (EUPs) submitted to the IMS are, on average, more likely to be adopted by the firm when compared to employee non-user proposals (ENUPs).*

Following the logic that employee-user proposals are either fully developed, partially developer, or rooted in a rich use experience, we explore if there is more than use benefit that contributes to higher likelihood of EUP's adoption. We test whether the existence of a solution specification, a prototype, or already used solution prior to submitting the innovation proposal will be positively associated with the likelihood of the proposal's adoption.

> *H1b: The level of development of an innovation proposal is positively associated with the likelihood of the proposal's adoption by the firm.*

Researchers who studied experiments with the lead user method in 3M, a U.S. manufacturing company, or Cinet, an IT system integration firm in Norway, find that the majority of the lead user ideas were embedded in new, often "breakthrough" products (Lilien et al., 2002; Olson & Bakke, 2001). The

researchers noticed a tendency among user innovators to think and experiment in a way that often differs from the established trends, an attractive property that makes it valuable for firms to have user innovators involved in the new product ideation phase (Franke et al. 2006; von Hippel 1986).

Involving users in a search for innovative ideas and solutions is not likely to be a good strategy if users have very limited knowledge of a technology (Magnusson, 2009). In such cases, users have low ability to leverage the technology's potential, and the outcome may not be worth the efforts of coordinating user involvement (Magnusson, 2009). If we follow this reasoning, the ideal user involved in a corporate innovation process should have a good grasp of technology, or at least easy access to those with knowledge and expertise, rich use experience, as well as relevant need-based thinking patterns. Employees who have hands-on experience with advanced and proprietary technologies and a pool of experts to interact with within close reach would certainly be among those most likely to have these properties. In the context of this research, these employees will also have access to a corporate IMS. When they experiment to indulge their curiosity, or address a keen need they experience, they may exhibit the same unusual thinking patterns that may lead to innovations that significantly change existing practices, products, and services.

Motivated by the positive experiences from ideation with lead users, we explore the impact, that is, the extent of change the innovation proposals are expected to introduce in the existing portfolio of products, services, and processes.

> *H2: Employee-user innovations (EUPs) submitted to the IMS have, on average, higher impact than employee-non-user innovation proposals (ENUPs).*

THE RESEARCH CONTEXT, DATA COLLECTION, AND METHODS

The research context

We test our hypotheses using a dataset of innovation proposals submitted to the IMS of a branch of a large ICT firm.[3] The innovation process is well specified and designed to rely extensively on the IMS, which makes it particularly appealing as a context for our study. All employees can submit their proposals[4] to the IMS, which upon submission go through a four-step evaluation procedure. The

[3] The branch has about 1,600 employees; about 600 work in the R&D department. Source: Annual Report for 2009, and confirmed by the manager in a conversation in October 2010.
[4] When the system was introduced in 2000, only employees of the R&D department were allowed to submit suggestions. In 2007, access was opened to all the employees in the subsidiary.

procedure is designed to ensure that the evaluators' potential bias, such as in the field of application of the proposals or the authors' background, is reduced to a minimum. An innovation manager assigned to manage the proposal evaluation starts by verifying if the basic information required to correctly interpret the idea is entered. In the next phase, one or a few designated experts from the field evaluate the proposal and send their recommendation to the next hierarchical level - the innovation management steering group on the level of the corporate department. Usually five members attend the assessment meetings, review the proposal, and jointly propose a decision. Their decision is then validated by the firm-level innovation management steering group, a body of five or more people. Proposals reach adopted or implementation status in either the departmental or firm-level steering group meeting. Innovation steering groups are organized periodically, when the number of proposals reaches a critical level that justifies such an activity.

The proposal submission is a voluntary effort by employees. Evaluators have no time constraints for completing the evaluations, but in practice, authors generally receive feedback on their proposals within a month of submission.

Data collection

We collected data from four sources: the idea management system, coded descriptions of the proposals provided by the independent coders, corporate human resource management system (HRMS), and information collected during qualitative in-person interviews. An advantage of working with the IMS is the existence of structured data, a database with records of the submitted innovation proposals. We focus on the innovation proposals submitted during the period from January 2009 to October 2010.

For reasons of confidentiality and to avoid bias, a group of knowledgeable coders from the firm with access to the innovation proposals independently coded the proposals as employee-user innovation or not. Seven coders used a software tool provided by the research team. The software tool embodies 18 questions on various aspects of the proposals, such as to which of the business lines the proposal applies, whether it is related to a product, service, or business process, and the extent of change the idea introduces to the existing processes, products, and services. The coders read through the proposals and answered the 18 questions that our software quizzed them on for each proposal. The coders were not aware of our hypotheses in terms of the impact of user innovation, and among the questions, none explicitly asked the coders to determine whether a proposal is an employee-user innovation, as this task was to be completed by the research team using a predefined algorithm (Figure 1) further explained below. The research team maintained contact only through the coders' supervisor, who was partially informed about the research objectives.

Although there are records of innovation proposals submitted since 2000, we considered only those submitted between January 2009 and October 2010. We chose this limited period to make sure the coding was not too burdensome for the coders, and the results are meaningful. Recent proposals are likely better known and can be coded well relatively easy, especially since the coders also participated in evaluating many of the proposals. We reviewed annual reports and corporate newsletters to search for information indicating significant systematic changes that may have affected activities related to the IMS during the observed period. We concluded that, during the period of our analysis, there were no major changes in terms of exploitation of the IMS, its strategic role in the firm, or its operational context.

Human Resource Management officials provided information about the authors of the proposals at the date of the proposal submission. This included the author's age, tenure at the firm, academic education, and industrial training. Human Resources employees helped code information from their database, to avoid revealing private information to the research team. Ultimately, we matched data with the records from the HRMS and the proposals' coded descriptions.

To validate our understanding of firm practices and our interpretation of the data, we conducted three series of interviews: before designing the data-coding questionnaire, during the coding and data analysis period, and after the results emerged. Initially, we interviewed two innovators from the firm, the innovation managers' supervisor, and a top management representative. We familiarized ourselves with the innovation process practices, how the IMS was being used, employees' expectations regarding their proposal submissions, and the implementation of the evaluation process.

One of our concerns was the possible bias of extrinsic motivation[5] (financial reward, career progress), as formal or informal incentive schemes could influence employees to prefer submitting proposals after they materialize the idea, rather than proposing only a concept. An example of a source of bias is a higher official reward guaranteed if a proposal describes a (partially) implemented idea. From the information gathered during the interviews, we conclude that all the interviewees unanimously believe that, although the materialization of the idea may be the sign of a well-thought-out proposal, the materialization does not change the evaluation process and does not guarantee the proposal will be adopted. We further explored this matter by asking the supervisor to assess the level of development of each of the proposals in two ways, by searching for keywords for the mention of implementation (solution, development, created, implemented, prototype and their written alternatives), and by examining the text for all the ideas after the automated search.

[5] We interviewed 6 innovation managers actively involved in the evaluation process and their coordinator in charge of implementing the innovation policy.

Data analysis and coding required repeated interaction with the innovation managers' supervisor. We validated the coding through a detailed examination of 5% of randomly selected ideas.

Additionally, when the data became available and the first results of our analysis emerged, one of the authors of this paper spent a week at the firm conducting many individual interviews with the coders/innovation managers, the manager of the most successful department in terms of participation in the IMS, and the supervisor who coordinates all IMS-related activities. The third series of interviews validated the coding process, and verified the results.

The specific data we collected is presented in table 1.

Insert Table 1 about here

Explanatory variable – employee-user proposal (EUP)

To categorize the proposals we use the independent coding method. Beside the EUP and ENUP, we include a category Customer-proposals. As the IMS may capture user innovations by customer through intermediary employees, we included a question asking if the employee's proposal describes something that was originally a client's suggestion or implementation (Figure 1, path 1). We find 8 such cases.

The coding team was assigned by the firm, which assembled several innovation managers familiar with the innovation proposals. Coding instructions and other material for coding, developed by the research team, were delivered to the coding team by the innovation managers' supervisor. To identify employee-user proposals, we use the algorithm presented in Figure 1. With the exception of the question about the level of development of the proposal, all the questions in the algorithm were part of the questionnaire designed for coding the innovation proposals. The level of development question was answered by the supervisor who reviewed all the ideas.

Insert Figure 1 about here

The key variable for testing both hypotheses is the indicator of the employee-user proposal (table 1, variable: proposal origin – category 2). It communicates important information about the origin of the proposal, and the motivational factor.

To test the hypotheses, we first identify the employee-user proposals and quantify their share of the observed population of innovation proposals and the share of user innovators in the population of employees who submit their ideas to the IMS. To test the importance of the employee-user proposals and their general impact, as stated in hypotheses 1 and 2, we develop a set of multivariate regression models.

Dependent variables

To test hypothesis 1, we use an adoption metric where the status of the proposal being accepted indicates that it is adopted.[6] We compare the regression results using two different dependent variables, first the proposal status "accepted" and then the status "implemented." Since both variables are binary indicators (see table 1), we develop and test multivariate logistic regression models.

For the second hypothesis, we use as the dependent variable the impact of the proposals, a subjective measure (on a seven-point scale) of the extent of change as perceived by the innovation managers. Given the ordered nature of the variable, we initially use an ordinal logistic regression model to estimate how our explanatory variables, in particular employee-user innovation, influence the probability of the various levels for the extent of change. We also consider the generalized ordered logistic and multinomial logistic models as alternatives.

Control variables

To identify the effect of the employee-user innovation, we control for influences related to the author, the nature of the proposal, and the organizational environment. We continue with a brief discussion of the control variables, mainly focusing on variables that do not have a straightforward interpretation.

The literature suggests that the IMS is traditionally seen as a tool for cost savings, and small and achievable improvements. Research shows that advertised strategic orientation creates high differences in the number of innovation proposals, the adoption rate, and their value (Van Dijk & Van den Ende, 2002). Therefore, strategic orientation may impact the evaluation process and become a source of bias in our models. To control for such bias, and the evaluation committee's propensity for innovation proposals that enhance only the current portfolio, we include in our regressions information about the type of innovation

[6] We tried to find a precise metric for the success of the idea that would ideally be an estimation of monetary benefit. Unfortunately, this information was not available.

proposal. This information is provided by the coders who characterized whether the innovation proposals represent an improvement, a new product or service, an internal tool, or something else.

An additional aspect we consider is the effect of teamwork on the probability of a proposal being adopted. Extant literature suggests that teamwork enhances learning in the work context (Amabile, Conti, Coon, Lazenby, & Herron, 1996) and the value of the innovation at work (Naveh & Erez, 2004). In the context of the IMS, more than one author may be interpreted as a sign of a well-thought-out proposal. Our control is an indicator variable that captures general preferences of the evaluation committee regarding teamwork.

The most important constitutive part of the successful IMS is the author of a proposal. In addition to basic demographics, such as age and gender, we include variables that depict characteristics pertinent to the authors that may influence their skills and their ability to articulate ideas proposed in the IMS. There are three ways for individuals in a firm to acquire knowledge and skills: academic education, formal industrial education, and informal acquisition of knowledge of the particular circumstances of time and place.[7] The type of knowledge acquired may come with the position in the firm. We control for these effects, as well as for the influence by including the information about the author's hierarchical level in the firm. We include information on the highest degree the author holds, as well as the number of trainings the author attended (as recorded in the HRMS). Knowledge related to employees' workplace and duties is best acquired with experience, especially for the tacit component. We include tenure length to control for job-related tacit knowledge, approximating it with the time the authors spent in the firm relative to the proposal submission. However, tenure length does not convey information about cross-departmental experiences, the strength of the employee's contacts network, and the diverse knowledge about the firm an individual acquired. The firm's Human Resources department staff, at our request, provided coded information on whether the authors had cross-specialty training. We include this information as a proxy to control for the otherwise unobserved heterogeneity in authors' experiences in the firm.

In the period we consider in our study, the firm had a general goal to stimulate as many proposals as possible with a symbolic reward for every submission. Although the firm expected this incentive would attract good proposals, it may also attract lower quality proposals from individuals who are more sensitive to incentives. We control for the effects of this incentive scheme by including information on whether the author is a "serial idea generator." This information characterizes attitude in communicating proposals

[7] Friedriech Hayek distinguishes two types of knowledge, manager's *aggregate* knowledge and worker's knowledge *of the particular circumstances of time and place* (Hayek, 1945).

using IMS, and may pick up a confounding effect of the author's reputation. However, the effect should not distort conclusions related to the employee-user innovation.

Consistent with the literature, we control for the department and business lines (portfolio) fixed effects, to approximate for a range of managerial and work conditions factors that may influence the success of the innovation proposals. The literature suggests supervisory support may have an important influence on individuals to submit proposals (Ohly et al., 2006) (Oldham & Cummings, 1996), and job complexity may lead to more attempts to improve and innovate business processes (Frese, Kring, Soose, & Zempel, 1996). The work environment, and in particular freedom in performing duties, or balanced job control, is positively related to innovative behavior (Amabile, 1988; Ohly et al., 2006). In contrast, investigating individual innovation in a subsidiary of a Japanese consumer electronics manufacturer in Singapore, Ong et al. (2003) did not find a significant relationship between job complexity, organizational support, or supervisory support and individual innovation. With department and business lines controls, we approximate the effects of different management styles and job complexity, but also differences in implementing the corporate strategy within the firm.

Time controls address unaccounted-for firm-level changes in the system in calendar years 2009 and 2010. Additionally, changes in market demand may influence authors to propose more, and evaluators to change preferences and favor proposals that could be applied in areas with higher expected market activity. Through the questionnaire, we asked coders to provide information about the proposed innovation's expected client. We use that information as a proxy to control for the market demand fixed effects, and control for the variation in adoption that arises with the influence of the otherwise unobserved market changes.

RESULTS

Incidence and type of EUP

In total, 759 innovation proposals were submitted to the IMS during the observed period, and afterwards coded by the firm's coders. Using the algorithm (Figure 1), 46 (6%) of the proposals are classified as EUP (Table 2). We observe relatively low employee involvement; a few less than one sixth (245 out of 1600) of employees of the subsidiary with access to the IMS submitted proposals. The share of EUP in the population of employees who submit innovation proposals is 14% (33 out of 245). Ten of the employee-user innovators submitted more than one innovation proposal. The observed share of employee-user innovators and their contributions should be seen as the lower boundary, as the literature suggests that

other employee-user innovators may not report their innovations using the IMS. Employees with a bachelor's degree reported the majority (80%) of the EUPs; those with a master's degree submitted 15% (7) of these innovations, and no employees with a PhD degree submitted employee-user innovations. Contributions by female employees accounted for 7% (49 out of 759) of the submitted innovation proposals. Out of 245 employees who submitted innovation proposals, 17 (7%) are female. Considering EUPs only, the share of female contributors (3 out of 46) and their contributions (2 out of 33) is 6%.

The EUPs were not only internal processes, methods, or tools. Some became products or services to be offered internally (within the global corporation) or to the market. One example of an EUP is a course for maintenance engineers developed by an engineer involved in telecom equipment maintenance. Driven by dissatisfaction with the existing courses used for telecom equipment maintenance, he decided to collect a set of common mistakes and design a version of the course that would focus on troubleshooting these problems. His idea gained interest in his department, where the engineer and a few colleagues experimented and further developed the course to use internally for their own department. Eventually, they decided to submit a proposal in the IMS to offer the course to colleagues with a similar need in other subsidiaries. Shortly after the course was launched, it attracted significant interest across the global corporation and generated additional revenue for the firm.

Another example is software developed by an engineer who often had to perform the EDGE[8] network health check for corporate clients, which are telecom operators. The engineer, interested chiefly in making his own job easier, coded his activities for manually analyzing recorded logs of the equipment in base stations over an extensive period. The software evolved to an extent that the engineer was able to perform the network health check in a few hours, instead spending a few weeks with customers. After some time, the engineer decided to submit a proposal that described the innovation to the firm, and the software tool he proposed quickly became officially accepted at the global level. The tool completely changed the way the network health check service was delivered to the firm's clients. Instead of being charged as a separate service, it became complimentary when network equipment was purchased.

Insert Table 2 about here

The two examples, together with 44 other EUPs, became visible to a wider population in the firm (see table 3) when their authors decided to describe and propose the innovations to the firm as innovation proposals in the IMS.

[8] Enhanced Data GSM Environment - EDGE

We investigate the relative importance of this pattern of innovation for the firm by developing the analysis for hypotheses 1a, 1b and 2 in the following subsections.

Effects of EUPs on performance of the IMS

In this subsection, we present the results for analyzing the effects of EUPs on the performance of the IMS, using the multivariate logistic regression model, and variables presented in table 1. We interpret an increase in the odds of the proposal being implemented as an improvement in the IMS performance.

The frequency distribution of adopted proposals (see table 3) immediately suggests that an EUP is likely to have a positive influence on the performance of the IMS. Of all the implemented proposals, 19% are EUPs; their share among not-implemented innovation proposals is less than 1%.

Insert Table 3 about here

To explore further patterns indicated by the frequency distribution in table 3, we implement several regression models, with the (latent) dependent variable the adoption by the firm and the critical explanatory variable - the nature of the proposal. The results are presented in table 4, with each of the four models representing the inclusion of additional blocks of control variables. A decision in favor of model (1-4) is supported comparing measures of the overall fit based on Bayesian information criterion for the analyzed models (Long & Freese, 2006) .

Insert Table 4 about here

We find a positive and significant (at 1% level) relationship between the probability of implementation and EUP. The odds of an innovation proposal being adopted are increased by a factor of 71[9] for the proposals that describe EUPs. The results suggest no statistically significant relationship between our proxy for the quality of a proposal and the probability of its implementation, and the same is concluded for teamwork. When we consider the type of proposal, the estimated coefficients suggest that the general perception of IMS being dominantly incremental innovation channel is likely to be true. Both coefficients next to new service and new product proposal indicators are negative. However, only the new service proposal coefficient is significant at the 1% level. Compared to the product improvement baseline, the

[9] To calculate the odds ratio, we use the formula odds = e^{β} (Long & Freese, 2006), which in this case results in $e^{4.26}$=70.81.

odds of the proposal being implemented decrease by a factor of 0.2 for a proposal for a new service, everything else held constant.

We modeled the author's age and tenure at the firm to allow for diminishing effects after a certain point in time. However, the result is that only the linear part of the tenure is significant ($p<0.05$) and positive, with an increase in the odds of a proposal being implemented for a factor of 1.2 for every additional year of the employees' tenure, everything else equal. The interpretation is straightforward: the longer people are at the firm, the better they know the technology used in the firm, the areas that need improvement, and the interests and modus operandi of the people involved in the evaluation process.

In addition, the results suggest that the association of the extent of development of the innovation proposal is positive, but not statistically significant.

The evidence offered does not support hypothesis 1b, but supports hypothesis 1a.

As a robustness check, we compare the results of the regression of the probability of the proposal being accepted (table 5, model 2-2) with the results from the model (1-4), repeated in table 5.

Insert Table 5 about here

One reason to consider such a check is that, over time, the status of some accepted proposals might have changed to implemented, altering the influence of the EUP variable.

The results of this robustness check confirm support for hypothesis 1a, with significance at the 1% level for both adoption measures. However, the extent of development is positively ($p<0.05$) associated with the likelihood of an innovation proposal being accepted, increasing the odds of acceptance for a factor of 3.2 if the proposal describes an already developed solution as compared to a description of only idea, ceteris paribus. This indicates that further exploration is needed for concluding the findings related to hypothesis 1b, with a sufficient time distance for all the proposals to reach their final status.

Impact of EUPs

For the second hypothesis, we develop an ordinal logistic regression model to first test the relationship between EUPs and the extent of change the proposals introduce. The dependent variable contains information provided by the coders, who estimated the extent of change of each innovation proposal on a scale from 1 to 7. Since we observe a highly disproportional frequency distribution of proposals across

the categories of the variable “Extent of change,” with a peak in category 4, we modify the original variable with seven categories, and create a new categorical variable with only three categories: Low Extent of Change (original categories 1, 2, and 3), Medium Extent of Change (original category 4), and High Extent of Change (original categories 5, 6, and 7). By doing so, we reduce differences among coders in categorizing innovation proposals and relative differences among categories.

Although the results obtained from the ordinal regression concurred with our initial assumption that EUPs on average introduce a higher extent of change than other proposals submitted to the system, the model did not pass the Brant test for parallel regression assumption (Long & Freese, 2006). Our generalized ordered logistic model did not converge to interpretable results, and we thus opted to use the multinomial logistic model. We build three multinomial regression models by successively introducing different blocks of variables (see table 6 for the results). Overall, our results provide support for the second hypothesis.

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Insert Table 6 about here

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DISCUSSION AND LIMITATIONS

We empirically examine the incidence of user innovations among the employees of a large ICT firm, and their importance for the performance of the firm's IMS. The results support hypotheses 1a and 2, but we find mixed evidence for Hypothesis 1b. We find the overall share of EUPs in the population of innovation proposals is relatively small (6%). However, the odds of adoption increase by a factor of 71 if a proposal configures an EUI, and the estimated impact is higher compared to other innovation proposals in the IMS. These results suggest that firms may find more attention to the potential role internal users can play in the innovation process.

The results suggest that employees contribute to the idea management systems along the continuum of development of their ideas, from simple description of an idea, through specifications of both problem and possible solutions, to a developed solution that is already in use by the authors or as a part of an ongoing project. The importance of the findings is in the superior performance of the proposals that are rooted in a use experience, either as a self-developed solution, or description of the benefit of use. The addition of department and business-line fixed effects to our model has significant impact on the estimated likelihood of the

proposals. This impact is reflected both in a decrease of the coefficient value for the proposal origin (employee-user or customer) and extents of the proposals' development, and the decrease or loss of the statistical significance. This signals a need for further investigation if the effect is due to the leadership style in the business units (collaborative and encouraging environment), or characteristics of technology the employees are working with (maturity, availability of tools, openness for experimenting, etc.).

One limitation of this study is the fact that it is focused on the IMS of a single large ICT firm with skilled employees. The results of the study may vary for different firms and industries. Employees with skills in ICT have an abundance of tools, within the firm and outside from diverse technology communities, to exploit and experiment with their ideas, which not necessarily exist for other industries. In an environment with abundance of skill and tools for recombining knowledge, a departure from an established practice in work activities, or process innovation (Mitchell & Zmud, 1999), is a likely event. An advantage for the analysis being in a single firm is that we are able to include a significant amount of detail that allows us to take into consideration different explanations for the innovation proposals' performance. In addition, our unit of analysis is a single innovation proposal, and the IMS is a good source of structured data about employees' innovation proposals.

Our study contributes to practice and academic work in managing innovation in several ways. We argue that assessing user contributions to the firm innovation process may improve the understanding of where and how firms generate value. Identifying successful experiences and obstacles that prevent their emergence may help amplify best practices and improve the overall performance of corporate IMSs. A strategy that stimulates employees to behave as user innovators, share their solutions with a broad employee base, and work together on their improvements might stimulate self-mobilization of the innovative force within firms. Such a strategy includes a more flexible and open work platform that allows an exchange of ideas, knowledge, and practical implementations. That could serve not only to enable employees to communicate their accumulated experience in an activity(Zander & Kogut, 1995), but also to self-organize and mobilize internal innovation capacities, and relate to external resources in a form of open collaborative innovation (Baldwin & Von Hippel, 2011).

Numerous challenges are associated with providing and sustaining enabling conditions for EUIs, including sufficient levels of task execution autonomy, collaborative environment, and efforts to coordinate and pursue solutions that are not necessarily considered against the value of the regular work efforts. This implies that the user innovation efforts may conflict with performance targets and economic goals for individual employees and groups. However, our study suggests that the payoffs for appropriately addressing user innovations by employees may be substantial.

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Literature

Amabile, T. M. (1988). A Model of Creativity and Innovation in Organizations. In B. M. Staw & L. L. Cumming (Eds.), *Research in organizational behavior* (Vol. 10, pp. 123–167).

Amabile, T. M., Conti, R., Coon, H., Lazenby, J. J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of management*, *39*(5), 1154–1184.

Axtell, C. M., Holman, D. J., Unsworth, K. L., Wall, T. D., Waterson, P. E., & Harrington, E. (2000). Shopfloor innovation: Facilitating the suggestion and implementation of ideas. *Journal of occupational and organizational psychology*, *73*(3), 265–285.

Baer, M. (2012). Putting Creativity To Work: the Implementation of Creative Ideas in Organizations. *Academy of Management Journal*, *55*(5), 1102–1119. doi:10.5465/amj.2009.0470

Baldwin, C. Y., & Von Hippel, E. (2011). Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. *Organization Science*, *22*, 1399–1421.

Bogers, M., Afuah, A., & Bastian, B. (2010). Users as Innovators: A Review, Critique, and Future Research Directions. *Journal of Management*, *36*(4), 857–875.

Burt, R. S. (2004). Structural holes and good ideas. *American journal of sociology*, *110*(2), 349–399.

De Jong, J. P. J., & Von Hippel, E. (2009). Transfers of user process innovations to process equipment producers: A study of Dutch high-tech firms. *Research Policy*, *38*(7), 1181–1191.

Denyer, D., Parry, E., & Flowers, P. (2011). "Social", "Open" and "Participative"? Exploring Personal Experiences and Organisational Effects of Enterprise2.0 Use. *Long Range Planning*.

DiNucci, D. (1999, April). Fragmented future. *Print (Magazine)*.

Dyche, J. (2012, September). Shadow IT Is Out of the Closet. *Harvard Business Review*.

Enos, J. L. (1962). Invention and Innovation in the Petroleum Refining Industry. In U.-N. Bureau (Ed.), *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Vol. I, pp. 299 – 322). National Bureau of Economic Research, Inc.

Franke, N., Von Hippel, E., & Schreier, M. (2006). Finding Commercially Attractive User Innovations: A Test of Lead-User Theory. *Journal of Product Innovation Management*, *23*(4), 301–315.

Frese, M., Kring, W., Soose, A., & Zempel, J. (1996). Personal initiative at work: Differences between East and West Germany. *The Academy of Management Journal*, *39*(1), 37–63.

Frese, M., Teng, E., & Wijnen, C. J. D. (1999). Helping to improve suggestion systems: Predictors of making suggestions in companies. *Journal of Organizational Behavior*, *20*, 1139–1155.

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics*, *10*(3), 5–25.

Girotra, K., Terwiesch, C., & Ulrich, K. T. (2010). Idea Generation and the Quality of the Best Idea. *Management Science*, *56*(4), 591–605.

Hastings, R. (2011). SHRM Poll: Employee Suggestion Programs Underutilized. *Ideas and Inspirations*, pp. 2–4.

Hayek, F. A. (1945). The use of knowledge in society. *American Economic Review*, *35*(4), 519–530.

Kijkuit, B., & Ende, J. Van Den. (2010). With a little help from our colleagues: a longitudinal study of social networks for innovation. *Organization Studies*, 492–510.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & Von Hippel, E. (2002). Performance assessment of the lead user idea-generation process for new product development. *Management Science*, *48*(8), 1042–1059.

Long, J. S., & Freese, J. (2006). *Regression models for categorical dependent variables using stata*. Stata Corporation.

Magnusson, P. R. (2009). Exploring the Contributions of Involving Ordinary Users in Ideation of Technology-Based Services•. *Journal of Product Innovation Management*, *26*(5), 578–593.

McAfee, A. (2006). Enterprise 2.0: The dawn of emergent collaboration. *Sloan Management Review*, *47*(3).

Meister, J. C. (2011, September). Increase Your Company's Productivity With Social Media. *Harvard Business Review*.

Mitchell, V. L., & Zmud, R. W. (1999). The Effects of Coupling IT and Work Process Strategies in Redesign Projects. *Organization Science*, *10*(4), 424–438. doi:10.1287/orsc.10.4.424

Naveh, E., & Erez, M. (2004). Innovation and Attention to Detail in the Quality Improvement Paradigm. *Management Science*, *50*(11), 1576–1586.

Ohly, S., Sonnentag, S., & Pluntke, F. (2006). Routinization, work characteristics and their relationships with creative and proactive behaviors. *Journal of Organizational Behavior*, *27*(3), 257–279.

Oldham, G. R., & Cummings, A. (1996). Employee creativity: Personal and contextual factors at work. *The Academy of Management Journal*, *39*(3), 607–634.

Oliveira, P., & Von Hippel, E. (2011). *Users as service innovators: The case of banking services*. *Research Policy* (Vol. 40, pp. 806–818).

Olson, E. L., & Bakke, G. (2001). Implementing the lead user method in a high technology firm: A longitudinal study of intentions versus actions. *Journal of product innovation management*, *18*(6), 388–395.

Ong, C.-H., Wan, D., & Chng, S.-H. (2003). Factors affecting individual innovation: an examination within a Japanese subsidiary in Singapore. *Technovation* (Vol. 23, pp. 617–631).

O'Reilly, T., & Battelle, J. (2009). *Web Squared: Web 2.0 Five Years On.*

Therrien, P., & Léonard, A. (2003). Empowering employees: A route to innovation. *Statistics Canada: The Evolving Workplace Series*, (613), 7887–7887.

Toubia, O. (2006). Idea generation, creativity, and incentives. *Marketing Science*, *25*(5), 411.

Tucker, A., & Singer, S. (2012). Key Drivers of Successful Implementation of an Employee Suggestion-Driven Improvement Program.

Urban, G. L., & Von Hippel, E. (1988). Lead User Analyses for the Development of New Industrial Products. *Management Science* (Vol. 34, pp. 569–582).

Utterback, R. (2012, November). GE's Colab Brings Good Things to the Company. *MIT Sloan Management Review*, (54206).

Van Dijk, C., & Van den Ende, J. (2002). Suggestion systems: transferring employee creativity into practicable ideas. *R&D Management*, *32*(5), 387–395.

Von Hippel, E., De Jong, J., & Flowers, S. (2010). Comparing Business and Household Sector Innovation in Consumer Products: Findings from a Representative Study in the UK. *Social Science Research Network*.

Von Hippel, Eric. (1986). Lead users: a source of novel product concepts. *Management science*, *32*(7), 791–805.

Von Hippel, Eric. (1988). *The sources of innovation. World Development* (Vol. 132). Oxford University Press New York;

Von Hippel, Eric. (1994). "Sticky information" and the locus of problem solving: Implications for innovation. *Management science*, *40*(4), 429–439.

Von Hippel, Eric. (2010). Open User Innovation. *Handbook of the Economics of Innovation, Volume 1* (1st ed., Vol. 01, pp. 411–427). Elsevier B.V.

Zander, U., & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization science*, *6*(1), 76–92.

Appendix A – Tables and figures

TABLE 1
Description of variables, types and coding

Related to:	Nr.	Variable	Measure type	Description/expected relationship
Dependent Variables	D1/2	Probability of idea accepted/ implemented	Binary	Adoption of the innovation proposal; We experiment with two measures, one is the status of the innovation proposal "accepted", and the other the status "implemented"; 0 – not accepted/implemented, 1 – accepted/implemented
	D3	Extent Of Change	Categorical (3 levels)	A variable with 3 levels, indicators of data coder's subjective perception of the extent of change the proposed idea represents to the existing service, product, process, or the other. 1 (low impact); 2 (medium impact) and 3 (high impact; significant changes, up to a new service, product, or a process).
Author / Personal	1)	Gender	Binary	0 – Male; 1 – Female
	2) /3)	Age / Age squared	Continuous	Age of the author (in years)/ Squared age of the author
	4) /5)	Years of Tenure/ Years of Tenure Squared	Continuous	Number of years of tenure the author spent in the firm / Squared Years of tenure. Relates to the firm specific experience, technology and firm-specific political know-how.
	6)	Managerial Level	Categorical (3 categories)	Three hierarchical levels: 1. Non-supervisor; 2. Supervisor / coordinator / technical expert; 3. Manager /director
	7)	Academic title	Categorical (4 categories)	Academic Education, the highest degree: 1 - without a university degree; 2 – Bachelor degree; 3 – Master degree, 4 – PhD degree
	8)	Combined Industrial Training	Continuous	An indicator of the investment in an individual, which also may indicate higher expectations in performance (not necessarily in IMS). It is a sum of counts of the following trainings: **1. External, web based training** (Employees receive industrial training offered online by educators from outside; nr of trainings/courses.) **2. External, instructor led training** (Employees receive industrial training delivered by an instructor. Nr. of trainings/courses.) **3. Internal training (nr of certificates/courses) (**Employees receive training delivered by educators employed in the firm. Nr. of trainings/courses.)
	9)	Number of Conferences Attended	Continuous	Number of scientific conferences attended by the author.
	10)	Cross Specialty Training	Binary	An indicator that is switched to one if the author had cross specialty training. Coding: 0 - no cross-specialty trainings (external or internal); 1 - employee attended trainings in at least two different specialties;
	11)	Serial idea generator	Categorical (3 categories)	Authors with multiple proposals over the observed period are called serial idea generators. 0 – one innovation proposal only; 1 - low serial IG with less than 4 proposals over the period; 2 – moderate, with 4 and more submissions
Environment	12)	Department	Categorical (6 categories)	One category for each of the departments where the innovation proposal originates
	13)	Business Line	Categorical (16 categories)	Each of the categories represents one of the activities from the portfolio; some examples are: eHealth solutions, fixed telephony switching centers, internal tools, and other. Activities are particular business lines. Matrix of frequencies of innovation proposals by activities and departments is not a diagonal matrix.
Idea	14)	Proposals origin	Categorical (3 categories)	Where and how proposals originate: 0 – Employee-non-user proposal (ENUP); 1 – Employee-user proposal (EUP); 2 – Customer's proposal.
	15)	Level of Development	Categorical (3 categories)	Three categories: 1 – a description of an idea ; 2 – specification of a problem and possible solutions; 3 – already developed solution with instruction for use, or further use.
	16)	Word Count	Continuous	Number of words used to describe the proposal in the electronic submission
	17)	Teamwork	Binary	An indicator variable switched to one when the proposal is a result of teamwork. Coding: 0 – Single author of the proposal; 1 – One author and one or more co-authors of the proposal
	18)	Client (control variable)	Categorical (5 categories)	Each of the categories represent expected client of the proposed solution/idea. 1 – Internal use or Global Corporation; 2 – Telecom Operator; 3 – Government; 4 – Enterprise; 5 – Other.
	19)	Idea type (control variable)	Categorical (7 categories)	Each of the 7 categories determines the nature of the innovation proposal; 1 – product improvement; 2 – new product proposal; 3 – service improvement; 4 – new service proposal; 5 – internal process, method or tool; 6 – working environment related ideas
Time (control)	20)	Year dummy	Binary	A control for the year specific changes; 0 – year 2009; 1 – year 2010

FIGURE 1
Algorithm for classifying innovation proposals into three categories: employee-user proposal (EUP), employee-non-user proposal (ENUP), and customer's proposal (CP)

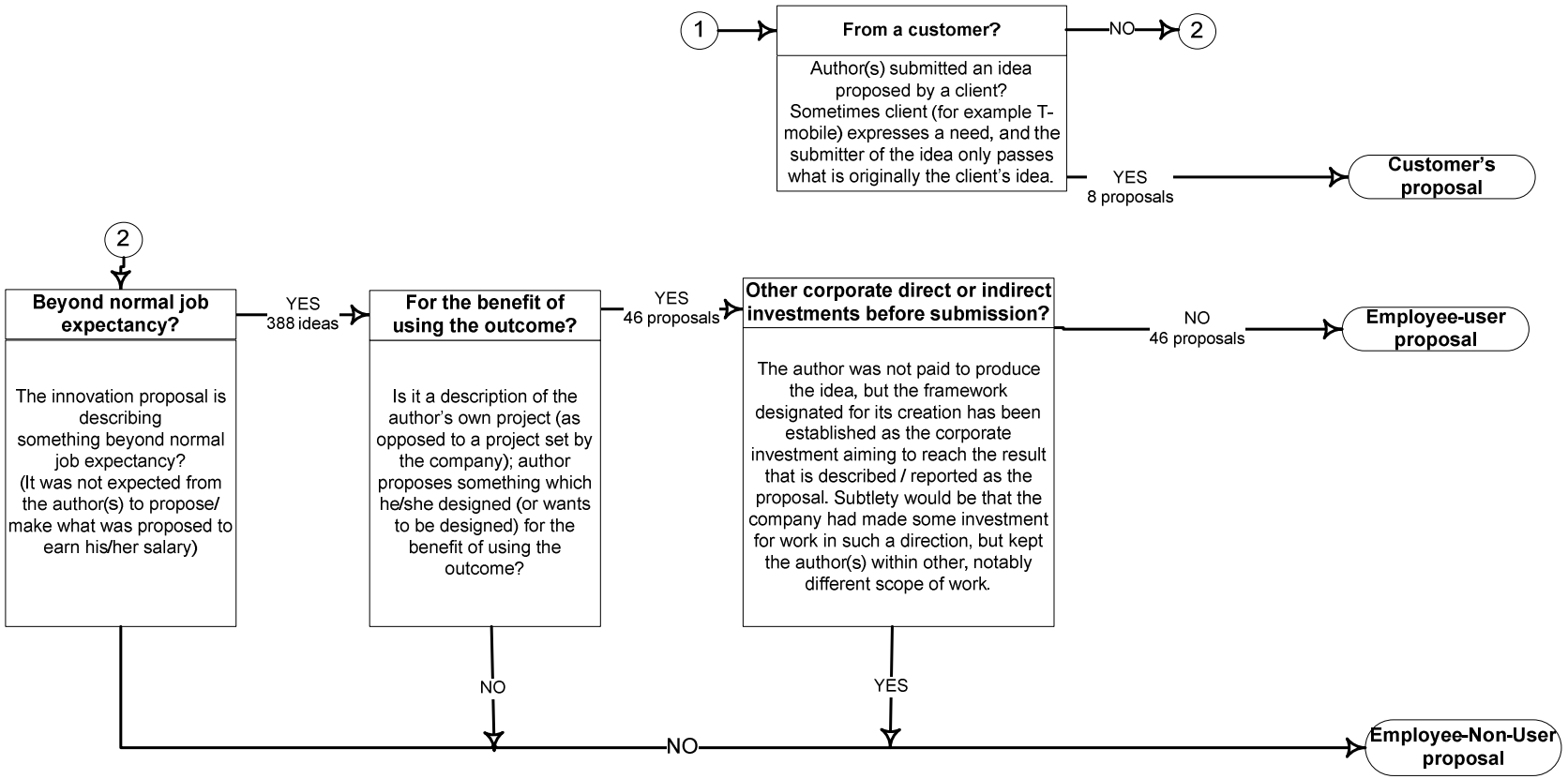

TABLE 2
Innovation proposal type by employee-user innovation; ENUP: employee-non-user proposal; EUP: employee-user proposal; CP: Customer's proposal

Nature of the proposed ideas	ENUP	EUP	CP	Row total:
Product improvement	133	17	3	153
New product proposal	34	4	1	39
Service improvement	33	6	2	41
New service proposal	91	5	1	97
Internal process, method or tool	348	14	1	363
ETK working environment related idea	43	0	0	43
Other	23	0	0	23
Column total:	705	46	8	759
Column percentage of 759:	92.89%	6.06%	1.05%	100%

TABLE 3
Innovation proposal status (implemented) by employee-user innovation; ENUIP: employee-non-user innovation proposal; EUI: employee-user innovation

	ENUP	EUI	CP	Row Total
Implemented	188 (80.7%)	43 (18.5%)	2 (0.8%)	233 (100%)
Not implemented	517 (98.3 %)	3 (0.6%)	6 (1.1%)	526 (100%)

TABLE 4
Logit estimates of likelihood of innovation proposal reaching status implemented [a] [b]

Group of variables related to	Model: (number) description	(1-1) Base	(1-2) Idea type	(1-3) Idea & Author	(1-4) Idea, Author & System
	Explanatory variables	Dependent variable: Probability of idea being implemented			
Idea (nature, quality of proposal, client, change demand)	Employee User Proposal	3.67***	3.70***	3.90***	4.26***
	Customer Proposal (ENUP omitted)	-0.09	0.19	-0.03	1.10
	Word Count, Team Work, and Market demand fixed effects		Yes	Yes	Yes
	Idea Type 2 (New product proposal) *(product improvement is the reference)*		-0.27	-0.60	-0.46
	Idea Type 3 (Service improvement)		0.06	0.28	0.73
	Idea Type 4 (New service proposal)		-1.43***	-1.66***	-1.72***
	Idea Type 5 (Internal process, method or tool)		-0.39	-0.38	-0.08
	Idea Type 6 (working environment related idea)		-1.17**	-1.13**	-0.33
	Idea Type 7 (other)		-2.38**	-2.28**	-1.51
	Extent of development – specification of solution (omitted is the idea only)		0.56**	0.57**	0.33
	Extent of development – with developed solution (prototype)		1.46***	1.46***	0.84
Author	Female *(male is omitted category)*			1.64***	1.80***
	Years of Tenure			0.15**	0.23**
	Years of Tenure Squared			-0.01	-0.01
	Age			0.25	0.11
	Age Squared			-0.00	-0.00
	Academic education, Cross Specialty Training, Number of Conferences attended (*controls*)			Yes	Yes
	Managerial level – supervisor / tech expert *(non-supervisor is omitted category)*			-0.33	-0.27
	Managerial level – manager			-0.01	0.30
	Moderate serial idea generator (*regular idea generator is omitted category)*			0.09	0.31
	High serial idea generator			0.65***	0.19
System	Department, Business lines, and Year fixed effects				Yes
	Constant	-1.01***	-0.47	-6.66	-3.26
	Observations	759	759	759	759
	McFadden's pseudo R2	0.093	0.17	0.24	0.32
	BIC	862.133	875.857	904.508	921.490
	Log-likelihood	-424.4	-386.0	-357.4	-317.9

[a] Regression coefficients shown.
[b] Regression performed with robust variance estimator
* p<0.1; ** p<0.05; *** p<0.01

TABLE 5
Logit estimates of likelihood of innovation proposal reaching status implemented, and accepted [a] [b]

Group of variables related to	Model: (number) description Explanatory variables	(1-4) Prob(proposal implemented)	(2-1) Prob(proposal accepted)
Idea (nature, quality of proposal, client, change demand)	Employee User Proposal	4.26***	3.09***
	Customer Proposal (ENUP omitted)	1.10	1.80**
	Word Count, Team Work, and Market demand fixed effects	Yes	Yes
	Idea Type 2 (New product proposal) *(product improvement is the reference)*	-0.46	0.31
	Idea Type 3 (Service improvement)	0.73	0.61
	Idea Type 4 (New service proposal)	-1.72***	-0.64*
	Idea Type 5 (Internal process, method or tool)	-0.08	-0.16
	Idea Type 6 (working environment related idea)	-0.33	-0.05
	Idea Type 7 (other)	-1.51	-1.03
	Extent of development – specification of solution (omitted is the idea only)	0.33	0.42**
	Extent of development – with developed solution (prototype)	0.84	1.16**
Author	Female *(male is omitted category)*	1.80***	1.00**
	Years of Tenure	0.23**	0.06
	Years of Tenure Squared	-0.01	-0.00
	Age	0.11	0.26
	Age Squared	-0.00	-0.00
	Academic education, Cross Specialty Training, Number of Conferences attended (*controls*)	Yes	Yes
	Managerial level – supervisor / tech expert *(non-supervisor is omitted category)*	-0.27	0.17
	Managerial level – manager	0.30	0.47
	Moderate serial idea generator (*regular idea generator is omitted category)*	0.31	-0.11
	High serial idea generator	0.19	-0.11
System	Department, business lines. Year fixed effects,	Yes	Yes
	Constant	-3.26	-3.26
	Observations	759	759
	McFadden's pseudo R2	0.32	0.32
	BIC	921.490	921.490
	Log-likelihood	-317.9	-317.9

[a] Regression coefficients shown.
[b] Regression performed with robust variance estimator; * p<0.1; ** p<0.05; *** p<0.01

TABLE 6
Multinomial Logit estimates of likelihood of the Extent of Change

		Model (1)		Model (2)		Model (3)	
	Outcomes	Low-impact	High-impact	Low-impact	High-impact	Low-impact	High-impact
	Independent variables						
Idea (nature, quality of proposal, client, change demand)	Employee User Proposal	-2.76**	0.82**	-2.48**	0.96*	-2.17*	1.15*
	Customer Proposal (ENUP omitted)	0.73	0.96	0.57	1.01	-0.00	0.02
	Word Count, Team Work, and Market demand fixed effects			Yes	Yes	Yes	Yes
	Idea Type 2 (New product proposal) *(product improvement is the reference)*			-0.59	2.80***	-0.69	2.95***
	Idea Type 3 (Service improvement)			1.04**	2.62***	0.35	1.19
	Idea Type 4 (New service proposal)			-0.68*	2.35***	-0.76	2.35***
	Idea Type 5 (Internal process, method or tool)			0.76**	1.51***	0.17	1.80***
	Idea Type 6 (working environment related idea)			1.75***	2.95***	1.22	2.94**
	Idea Type 7 (other)			0.67	2.11***	-0.13	1.58
	Extent of development – specification of solution (omitted is the idea only)			-0.63***	-0.43*	-0.19	0.14
	Extent of development – with developed solution (prototype)			-1.03	-0.16	-0.16	0.17
Author System	Female *(male is omitted category)*	-0.34	-1.02**	-0.49	-1.48***	-0.35	-1.48
	Years of Tenure	0.06	-0.02	0.09	0.00	0.10	0.07
	Years of Tenure Squared	-0.00	0.00	-0.00	0.00	-0.00	-0.00
	Age	0.09	0.21	0.14	0.24	0.25	0.29
	Age Squared	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	Academic education, Cross Specialty Training, Number of Conferences attended (*controls*)	Yes	Yes	Yes	Yes	Yes	Yes
	Managerial level – supervisor / tech expert *(non-supervisor is omitted category)*	0.52	0.70*	0.35	0.51	0.22	0.27
	Managerial level – manager	-0.26	-0.30	-0.08	-0.33	-0.13	-0.30
	Moderate serial idea generator (*regular idea generator is omitted category)*	-0.28	-0.76***	-0.26	-0.73***	-0.19	-0.53
	High serial idea generator	-0.91***	-2.03***	-0.83***	-2.18***	-0.28	-0.18
	Department, business lines. Year fixed effects,	Yes	Yes	Yes	Yes	Yes	Yes
	Constant	-0.92	-3.94	-2.44	-5.65	-23.50	-4.98
	Observations	759	759	759	759	759	759
	McFadden's pseudo R2	0.116	0.116	0.197	0.197	0.443	0.443
	Log-likelihood	-711.1	-711.1	-645.5	-645.5	-448.1	-448.1

* p<0.1; ** p<0.05; *** p<0.01