Crowdsourcing in the Fuzzy Front End of Innovation

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Abstract—**This paper begins presenting the different ways in which crowdsourcing could be adopted in the context of innovation. We then focus on its potential use in the Fuzzy Front End (FFE). An extant literature review allows us to identify the main success factors, issues, and challenges that should be considered if crowdsourcing is to be implemented into the FFE. We discuss what conditions could encourage or constrain its use as a strategic alternative in a more generalized way in the near future. Our study led us to many questions not yet explored in the research of Crowdsourcing, considering its specific use in the FFE. This paper contributes to the incorporation of non-traditional means in the management of innovation, because it proposes ways to integrate the theoretical and empirical findings about crowdsourcing with the management of the Fuzzy Front End. We also suggest some alternatives for further empirical research.**

I. INTRODUCTION

Not until the past decade that firms began to look outside their boundaries, searching for alternatives to the traditional model of innovation in the development of new products. Chesbrough [7] presents the contrast between this closed model of innovation and a new paradigm: the open innovation.

The unstoppable progress and massification of information and communication technologies is offering interesting alternatives to go even further with the opening of the innovation boundaries.

It is in this setting that "crowdsourcing", a term used in a generic way to evoke a great number of people interacting with an organization through the Internet to solve a task, appears as an appealing option to integrate in the innovation processes.

However, some problems and challenges remain. Many of these issues are found in the early stages of the innovative process, the "Fuzzy Front End" [30]. This phase, characterized by its uncertainty and managing difficulty has strategic importance for successful innovation undertakings.

Researchers identified that enterprises that successfully manage the FFE, for example paying attention to the voice of consumer, achieve greater rates of success in–new products development, profits and/or market share. [8].

An option to contribute to the management of this difficult phase is to use an open model with modern technologies and methodologies, such as crowdsourcing.

The use of external agents (organizations) to improve the management of the Fuzzy Front End stage of innovation has been considered [24], but not exploited yet. Even so, the use of a more extreme model, in which "common" people is also included as a source of innovation, has been seldom researched until recently (e.g. [29]).

This paper contributes presenting a systematic literature review about crowdsourcing and linking those findings with its potential application to the innovation FFE.

Idea genesis and selection, Opportunity identification and analysis, and Concept development are activities present in the FFE of innovation [23] and crowdsourcing appears to be an interesting way to contribute to all of them.

The potential numbers are overwhelming. According to IWS [19] there were approximately 2,405 million of internet users around the world as of June of 2012.

The firms interested in obtaining even a small fraction of the vast quantity of knowledge and talent dispersed around the world, may take advantage of the increasing use of IT tools nowadays.

An important consideration is worth mentioning. As its going to be explained ahead in the article, some models of crowdsourcing include many (if not the majority of) prospective and/or actual **customers** among these massive crowds.

Djelassi and Decoopman [9] state that the consumer left behind its role as a simple purchaser to become a protagonist in value co-creation. And the results don´t seem trivial. Like other studies, Djelassi and Decoopman [9] find that "products chosen by customers have generated the best sales figures every year."

However, if crowdsourcing is considered as an option to implement in the FFE, many considerations should be regarded, as we going to present later.

In the next section, we present some necessary basic concepts about Crowdsourcing and FFE. The third section is destined to explain the methodology of our review. The fourth section presents our review main findings concerning success factors and challenges. The discussion about the use of crowdsourcing in the FFE, based in our previous findings, is included in the fifth section. The final section is dedicated to new questions arising from our research and suggestions of some alternatives for empirical research on the subject.

II. SOME BASIC CONCEPTS

A. Crowdsourcing

We define Crowdsourcing as *the solving of a task by a crowd of people outside the organization, using online interaction* ([13], [3], [10]).

As FFE deals with generation, exploration and evaluation of ideas, as it does with concept and product definitions [21], we consider that some specification becomes necessary when working with that definition.

For instance, we distinguish between two crowdsourcing types: One generally consist in the realization of small, routinely, repetitive assignments. The other type encompasses

tasks that require a more complex level of contribution by the crowd. Estelles and Gonzalez [12] name the first type of activities as "simple", while the other activities are considered "complex" and "creative".

This research will focus on the second type, as indicated by our focus in the FFE.

Also, like Marjanovic et al. [26], this paper distinguishes crowdsourcing and *open source projects*. In the latter, for instance, solution seekers and solvers are not explicitly or clearly differentiated.

Considering the typology proposed by Estelles and Gonzalez [12] we postulate that the types *Crowdcasting* (the firm poses a problem or task to be solved to the crowd) and *Crowdopinion* (the firm asks for the crowd's opinion about a subject or product) could both be useful in the Fuzzy Front End of innovation.

Boudreau and Lakhani in [5] give their own classification of crowdsourcing approaches. For them crowdsourcing could adopt the form of Contests, Collaborative Communities, Complementors or Labor Markets.

We consider the first two approaches as more relevant to FFE management. In the first case, a competition for ideas or solutions is openly launched to the crowd, like Estelles and Gonzalez's crowdcasting definition [12], but adding a contest incentive to participation. In the second case, a distinguishable group with common interests co-works (giving more than just opinion) with the firm to develop an innovative outcome.

Finally, as Bogers and West [3] state, we believe that crowdsourcing could be considered generally as a form of *Distributed Innovation*, given its adherence to characteristics of open and user innovation, depending on the case.

B. Fuzzy Front End

Despite many definitions about the so-called "Fuzzy Front End" exist ([23], [20], [30]), we will adopt Kim and Wilemon's definition [21] for this research, considering the Fuzzy Front End (FFE) as "…the period between when an opportunity is first considered and when an idea is judged ready for development."

The "fuzzy" label is included after the characterization of this innovation phase as Uncertain, Low formalized, Unstructured [21], Unpredictable [23], Equivocal, Complex and Variable [6].

A graphic representation of the main ideas behind FFE could be observed in the graph below (Figure 1).

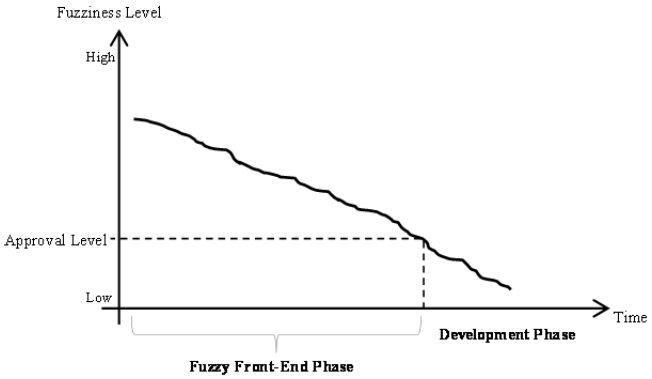

Figure 1. Graphic depiction of Fuzzy Front End adapted from [21]

Other authors, as Chang et al. [6], propose alternatives to this view, depending on the process dynamic in each particular case (Figure 2).

Using the categorization of companies proposed by Khurana and Rosenthal [20], it is possible to differentiate between the ones that are only aware of the FFE significance, and the others that realize the potential of an adequately coped and integrated front-end of innovation. We believe for the latter, that FFE management using new strategic alternatives, as opening via crowdsourcing for instance, could lead to strategic rewards.

III. METHODOLOGY

To find literature about our subject, we explored the databases of Web of Knowledge [31], Scopus [11] and IEEE Xplore [18].

The term "crowdsourcing" was used as keyword and considering the subject novelty[2] no data restriction was used in the searches. A summary of the number of findings is presented in Table 1.

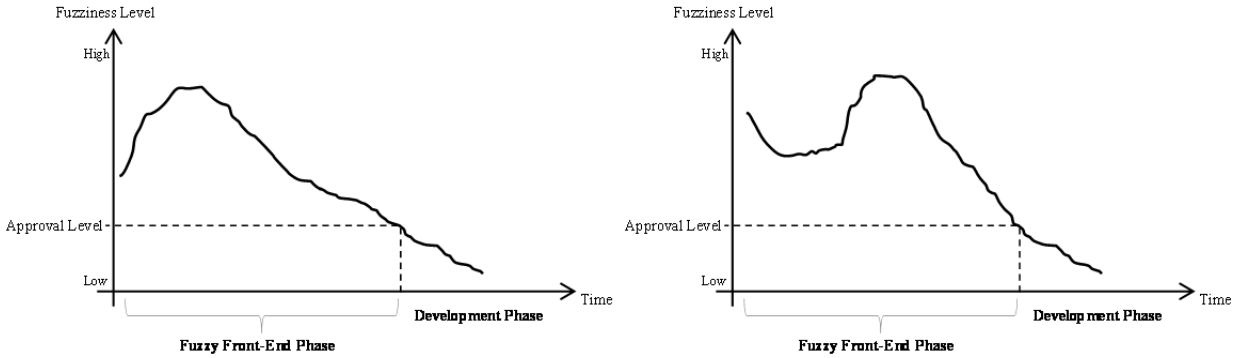

Figure 2. Variants in the FFE representation, adapted from Chang et al. [6]

[1] The term "crowdsourcing" was first used in a Howe's article of 2006 [16].

TABLE 1. SUMMARY OF FINDINGS WITH THE SEARCH TERM IN SELECTED DATABASES

Database	Number of results related to search term "crowdsourcing"
Web of Knowledge	638
Scopus	1716
IEEE Xplore	389

As an exploratory step we restricted our review to the Web of Knowledge database [31]. This database was selected to delimit the extension of our research, considering that it covers an important number of the highest impact journals and academic conference proceedings worldwide. However, in further work we expect to be able to explore the other two, to collect additional insights about the subject.

An initial title and abstract review allows us to exclude the articles and papers not related to innovation management. This way, we discarded crowdsourcing studies in areas like Public Sector, Medicine, Bioinformatics, Geography, Management of Disasters, Information Retrieval, Linguistics, History, Funding or Image Searching.

This step and a subsequent more detailed abstracts review left us with 188 publications, which were classified into categories defined by us, according to the main topics approached in the crowdsourcing research.

Although some categories could overlap (e.g. "Competition" with "Motivations" or "Definition" with "Management"), we try to identify the leading motive in each publication for classification purposes. The number of publications in each category can be viewed in table 2.

TABLE 2. NUMBER OF PUBLICATIONS ABOUT CROWDSOURCING BY CATEGORY.

Topic	Challenges	Competition	Contracts	Definition
Number of Publications	26	12	3	10

Topic	Experimentation	Management	Motivations	Rewards	TOTAL
Number of Publications	14	101	16	6	**188**

The category related to the research about management of the crowdsourcing process or the crowd itself appears as the more numerous in quantity of publications.

Despite the category "Management" probably could have been divided in sub-categories like "Management of Quality" or "Mechanism-Systems proposed for Management", we consider that the grouping proposed is pretty appropriate for our purposes.

A second group seems to be destined to the research of issues or challenges in the process (category "Challenges") and the driving forces behind the crowd's participation in these initiatives (category "Motivations").

The third group similar in quantity of publications comprise the categories of "Experimentation" with crowdsourcing, "Competition" itself and publications mainly devoted to define/describe the term ("Definition"). And the least quantity of publications corresponds to topics related to "Rewards" in crowdsourcing initiatives and "Contract" literature for the specific topic.

Then we focused on the articles specifically related to the subject of study, scrutinizing 54 publications (40 scientific articles and 14 journalistic-type publications) among them.

For each category and article, we check for the relevance of each publication basing us, mainly, in the number of citations, coverage of the research, methodology's suitability, and proximity to our interest research topic.

It should be noted that once these criteria are applied, the number of articles we finally include in this paper, is relatively small.

Next we present our main findings in this literature, regarding its potential connection with FFE topics.

IV. MAIN FINDINGS

A. About success factors

Afuah and Tucci [1] discuss about under which circumstances crowdsourcing is a better solution than solving innovation internally or with a designated partner. For them, the probability of crowdsourcing use by an organization will be higher if these conditions are present: 1) Problem easy to delineate and broadcast (including modularization feasibility), 2) Knowledge required is outside the internal knowledge, 3) Large crowd with motivated and versed members, 4) A final solution easy to evaluate and integrate, and 5) Low cost and widespread IT.

About the first of the five factors previously cited, Feller et al. [14] also consider that clarity and quality of problem descriptions enhance the process of knowledge transfer which crowdsourcing aims.

The second one seems to have similarity to Marjanovic et al. [26] findings, that state that companies "…tend to engage with crowdsourcing when innovation challenges are such that a clear contractor with the appropriate skills cannot be readily identified in advance, or where particularly out-of-the-box thinking and creative solutions to challenges with high degrees of uncertainty are being sought." [26, p.329].

In this source of external knowledge, another aspect of importance for the success in crowdsourcing processes seems to be the "diversity of perspectives and backgrounds" [14, p. 222].

The third condition in [1] makes a reference to **Motivations**, a subject mentioned by many researchers. Djelassi and Decoopman [9] reference the understanding of the participator's motivation as a direct factor of success. Vrabec [32] considers as needed factors for crowdsourcing to succeed, to have a relevant and interesting topic and to provide participants with satisfaction of their needs.

Among these motivation factors, as one of the categories of our methodology suggests, **rewards** seem to have an important role in some cases as an incentive for participation in crowdsourcing undertakings.

Feller et al. in [14] mention that rewards are a key element in crowdsourcing. They consider also that "sustaining the

participation of an appropriate community of innovation providers" is an essential component. [14, p. 220].

About incentives, Bukovic and Bartolini [33] divided these in *monetary* and *non-monetary*.

Afuah and Tucci, [1, p.358] say that "the need or desire [to solve problems] need not be solely monetary". In their comprehensive study of 2012, Feller et al. [14, p. 227] also discover that "…in some instances the non-financial rewards are viewed as being equally as, or sometimes more important than the financial rewards."

"Feedback" appears to be a central element to solution providers, as Feller et al. [14] say. Being it considered a reward in case of their presence and a frustration in case of their absence.

Seems important not underestimate the emotional factors that could guide some potential contributors to any of these initiatives. (e.g. testimonial in [9, p. 687]).

As Marjanovic et al. [26] shows in the case of Innocentive, anonymity of seekers and solvers appears to be another success factor for deals involving crowdsourcing. The same research ([26]) identifies, using the case of NESTA, other success factors. These include a challenge: clearly defined (as Afuah and Tucci [1] e Feller et al. [14]), outcome focused, staged and not prescriptive. The last factor identified was a competition "as open as possible".

Vukovic and Bartolini [33] consider among other factors: A crowd selection process and a good specification of intellectual property rights and processes. Here, we see the concern with reaching the right crowd (motivated and versed). And also, the need to have a clear position on property rights in order to motivate such a crowd.

About this last topic, Feller et al. [14, p. 223] discover that "protecting IP improves sharing of information by guaranteeing the innovation seeking firm can share a greater quantity of useful information without exposing themselves to risk."

"Trust by all parties in the system" is another element founded to be important for the success of these initiatives [14]. In this direction, provide explicit refereeing process and adequate information to participants to avoid concerns about accuracy and manipulation seems other important factor.

Bonabeau [4] also points as success factors the need of key metrics and indicators to evaluate the performance of this type of initiatives. For instance, some of these metrics could be the quality of solutions or the number of unexpected issues uncovered. Afuah and Tucci [1] say about the topic of performance evaluation in the solving of a problem that some measures could be the quality, cost, speed of the solution and/or simply its finding.

In contrast to the previously cited success factors, Djelassi and Decoopman [9] present possible elements that keep firms reluctant to use crowdsourcing. These might include a poor knowledge of the Web 2.0 environment and financial constraints because of return uncertainty. Other could have to be with timing reasons, as a manager interviewed in [9, p. 689] said: "people are not going to wait two years before you launch the product"

We summarize these success factors in grouped categories in Table 3.

B. About challenges

Boudreau and Lakhani [5] regard as managements challenges the need to identify, translate, and (probably) abstract the problem to make it available to the crowd of solvers. Other authors [1] also include the "risk of misrepresenting the problem" when making it understandable for the crowd, and the interaction cost. This last issue pointed by [1, p. 362] might suppose that "the cost of interacting with every member of a crowd that is interested in solving the problem can grow considerably with crowd size."

Djelassi and Decoopman [9] also consider a main challenge as the how to facilitate the interactions in crowdsourcing. They notice that the potential negative feelings of the practices must be managed carefully. These might include feelings of being exploited and/or cheated.

They also consider [9, p. 688] that "the successful implementation of a crowdsourcing operation requires a good match between the expected benefits for consumers and the behavior of companies in terms of transparency, quality of interaction, recognition of participants and ethics."

The management task of recognition appears as a key challenge, because as an interviewee responds in [14], the design of the reward system could be one of the most difficult things to do in the process.

TABLE 3. SOME SUCCESS FACTORS IN CROWDSOURCING USE FOUND IN THE LITERATURE.

Factor	**Reference**
Clarity in delineation and description of the problem	[1], [14], [26]
Knowledge required is outside the firm and out-of-the-box thinking is needed	[1], [26]
Crowd motivated, versed and diverse	[1], [9], [14], [32], [33]
Final solution easy to evaluate and integrate	[1]
Competition appropriately open	[26]
Anonymity of seekers and solvers *	[26]
Well defined processes about the challenge and the crowd	[14], [26], [33]
Good specification of IP related themes	[14], [33]
"Feedback"	[14]
Trust by all partakers	[9], [14]
Metrics and indicators to evaluate performance	[1], [4], [26]

* Might imply conflict, if non-monetary rewards as recognition are considered.

The Mechanism Design is a major issue for the author Bonabeau [4]. For instance, some questions arise: Should be better an equal voice for participants? How to select which one will have a greater voice? This challenge increases if we consider that "…even small changes to the design of a successful mechanism can lead to large, unintended negative consequences" [4, p. 50].

From the literature review, many questions emerge regarding issues of **ethics**, for example, opportunistic behavior by the crowdsourcer [1].

Other issue related to ethics consists in the great disparity that could happen between the reward obtained by the solver and the big gains that could result of its implementation by the firm that acquired the solution [14]. This of course is closely related to the distance between having an idea to solve a problem others pose and being able to implement and exploit this very same idea.

In the case of trial-experimentation, an issue could be that "…an opportunistic agent may decide to take advantage of information asymmetries." [1, p.363]

In [3], Bogers and West consider three things as challenges for firms interested in initiatives of distributed innovation, as crowdsourcing could be. These are: 1) identifying a supply of external innovations, 2) ensure it continues, and 3) find the way to appropriate value.

Feller et al. [14] present two approaches to manage the crowd composition: Maximize its number or Target a specific group. Then, this decision will be another challenge for the managers that want to implement the model.

A similar decision that needs to be made is the choosing of the crowd profile: Anyone can participate? Or a specific group is aimed? We believe that in the scheme in which innovation seeker defines the characteristics-skills of his potential providers [14], exists the risk that useful and interesting profiles could be disregarded.

In a similar concern, for Bonabeau [4], maintain a balance between diversity and expertise (Composition of the diversity) is a challenge for management.

Related to the second challenge presented by Bogers and West [3] about continuity, Albors et al. [2] cite "desertion" as a basic problem in virtual communities.

Bonabeau [4] also cites (lack of) "engagement" as an element, understanding that different incentives (cash, prizes, recognition, value-driven) will work depending of the activity.

Some authors advise that a particular tendency that should be considered is the ratio of participation or effectiveness. Nielsen, as cited in Vrabec [32], for instance presents the ratio of 90:9:1, which means 90% of spectators, 9% of enthusiasts and only 1% of really "creative" contributors.

Another issue could be that participators didn't see results soon and feel kind of demotivated [9]. This demotivation could also arise if the solutions contributed to the process are not considered as winners (which is the most probably outcome).

So, another possibly challenge seems to be to respond on adequate time to the expectations of the contributors in terms of the launching of the new product or innovation crowdsourced. (e.g. testimonial in [9]).

Other important thing observed is the "weak or non-existent" feedback between generation and evaluation that should be overcome [4].

In [27], Oliveira et al. made a reminder about considering organizational and cultural differences in crowdsourcing implementation. That could imply considering factors as size of the enterprise and motivations, rewards and recognition adapted according to a national culture. Related to this aspect is also the cited by Vukovic and Bartolini [33], about the legal and laboral issues regarding activities coexisting in different regions and jurisdictions.

Besides the already referenced, Bonabeu [4] points other challenges of choosing the approaches to deal with solution generation and evaluation using open collective intelligence:

- Policing behavior, which could became so demanding
- Intellectual Property

Among the issues that could confront crowdsourcing, Marjanovic et al. [26] cite the increase in the probability of failure in innovation due to less ownership of the problem; difficulties in monitoring and managing the project; and challenges related to work (quality, relationship and/or vulnerability to malevolent efforts).

In a similar way, research by Bonabeau [4] identified the loss of control (Unwanted outcomes, Unpredictability and Unassigned liability) as a problem.

Another risk pointed by Marjanovic et al. [26] is the exposure of future plans of innovation.

The general disclosing information to the exterior was cited as a trouble by Bonabeau [4], because "…if the collective veers in an unexpected and potentially harmful direction, the resulting damage could be difficult (and costly) to contain." [4 p. 48].

Vukovic and Bartolini [33] include as a challenge how to deploy crowdsourcing "… at the minimum cost to the business, while preserving the brand" and "achieve high quality contributions"

A challenge identified by the reading of the research of Djelassi and Decoopman [9] is the need of adaptation of the current business model by the firm interested in applying crowdsourcing practices. Some examples include designate or adapt a team internally to carry on these activities.

Next (Table 4) we present a summary of the findings resultant of our review.

TABLE 4. SOME FINDINGS ABOUT CHALLENGES IN CROWDSOURCING USE.

Challenges	Specificities	References
Problem related	• Identification • Representation	[5] [1]
Cost of Interaction		[1], [4], [9], [26], [33]
Motivation and Recognition of participants		[4], [9], [14], [27], [32], [33]
Ethics related	• Crowdsourcer firm • Participants	[1], [9], [14], [1], [26]
Ensuring continuity of the activity and engagement		[2], [3], [4], [14], [32]
Appropriation of value and IP related		[3], [4], [14], [33]
Related to the identification and composition of the crowd	• Number • Profile	[3], [14] [4], [14]
Organizational, Cultural, Legal and Laboral differences		[27], [33]
Less ownership and control of the process		[4], [26]
Disclosure and Exposure related		[4], [26]
Organization and Business Model adaptations		[9]

V. DISCUSSION

The first and apparently more suitable use of crowdsourcing in the FFE innovation is in the ***generation of ideas*** [25], [29]. The traditional model of new products development is challenged by the existence of an immense pool of talented and experienced people dispersed around the world that now could easily interact with extant communication technologies. A hitherto process limited to the creativity and solving capability of a closed and reduced internal team can now nurture itself from the capacities in this area, not only of another organization teams but also of unexpected ([17], [5]) individual talents that could provide the winning idea the firm is looking for. Kim and Wilemon [22, p. 36] already stated that "external groups are sources of valuable information and innovative ideas" in the FFE, and crowdsourcing appears to be a model that allows a substantial increase of these sources. Chang et al. in [6] referred to many researches that consider the fuzziness of the front-end as positive, mainly mentioning creativity and heterogeneity as elements that are present under these circumstances. With crowdsourcing, creativity and heterogeneity are multiplied to levels hardly reached with the usual approach at this stage of the development.

Olson and Rosacker [28] include among some pros and cons of Crowdsourcing that, for one side, it eliminates groupthinking and works well when high levels of creativity in little time are required. On the other side, crowds have variable quality and "cannot have the same depth and intimacy" as a group of experts.

Related to this topic is the finding of Albors et al. [2], who points out that, because of the characteristics of the interaction and reduction of norms, an equal participation between introvert and extrovert members could happen.

Nevertheless, crowdsourcing could contribute more beside the idea generation in the FFE.

If we consider the activities of front-end process presented by Khurana and Rosenthal [20], in the so called Pre-Phase Zero where the initial identification of the opportunity is placed, the use of crowdsourcing could imply a constant loop of new opportunities discovered from the activities carried on. However, it is important to note that the initial/original opportunity discovery will need to be proposed by the firm to initiate the process. The results of these feedbacks on new opportunities are unknown. Probably another challenge will be to identify and manage the great number of opportunities that could arise from the process of participation of externals in this FFE phase.

In their so called Phase-Zero, in which product concept and definition take place, other important differences should be expected, because a stage which is traditionally and generally conducted by a small group inside the firm, only sometimes including suppliers [20], is now open to a great crowd of people participating through crowdsourcing interactions. This implies, as we seen in the previous section, issues concerning information leakages and intellectual property.

The literature about FFE, mostly consider this stage finished when "…the unit either commits to funding, staffing, and launch of the project or kills the project." [20, p. 106]. This last decision could have a different implication for a firm that adopted crowdsourcing. As we have seen in Djelassi and Decoopman [9], much of the motivation to participate can be linked to faster realization of the innovation developed by crowdsourcing.

The product concept and definition are some other outcomes expected of the FFE phase [20] and with the use of crowdsourcing it should be expected that *the concepts are clearer, more explicit and more aligned with customer needs*, than if no massive participation had taken place.

Also, as Djelassi and Decoopman [9, p. 687] state "crowdsourcing is liable to reinforce the relationship between companies and customers". And proximity with the customer could become a precious asset in this phase of product development.

Khurana and Rosenthal [20] stated that a list of product features, whose input originated from R&D, Marketing, special customers and customer feedback might *solve gaps in product conceptualization*. When crowdsourcing intervenes it

is to be expected that external contribution could enrich even more this type of gap solution.

Crowdsourcing can also be used in many activities related to the *evaluation in the fuzzy front end*, requiring however specific design and management of the process. Afuah and Tucci [1] also note that creation-design and evaluation by the crowd could go together efficiently. However, Bonabeau [4] concludes that collective initiatives are more adequate for generation than evaluation of solutions. Thus, we are left with a research question: crowdsourcing effectiveness in FFE ideas assessment.

Khurana and Rosenthal [20, p. 112] consider of importance the existence of contingency plans as a tool for managing the risk of NPD. That could imply "develop alternative technologies in parallel". In some manner, crowdsourcing allows that by having different kinds of knowledge working to bring solutions to the same problem. Boudreau and Lakhani in [5] also talk about this kind of *parallel experiment running*.

However, despite crowdsourcing appears to be an ideal solution for this stage, given the issues and challenges presented in the previous section, many **considerations** should be taken into account:

The issue of *Intellectual Property* appeared in some of the reviewed literature. We believe this matter will require special management in the FFE. For us, the main concerns seem to flow in two directions. From the company to the externals (disclosure) and from the crowd to the company (How to assume ownership of the idea?).

Another thing that should be considered is that the *front-end roles* (as stated in [20]) *will change* in a crowdsourcing context. The core FFE team, will probably have more decisions to make, as a result of the numerous and diverse options yielded by the crowdsourcing process. Thus, the team's traditional role as producers of definitions shall receive less weight, while more weight will be given to its role as evaluators.

This will probably be a key aspect in this new model, because, not only a cross-functional team will be needed [20], but also they will have to have more specialized skills, knowledge and experience, to let them accomplish their new roles.

Khurana and Rosenthal, [20] recommend many definitions regarding the roles in the front-end process, including defining a responsibility for the balance between thoroughness and speed. In the case of the use of crowdsourcing, this challenge probably will be harder, because the additional pressures to develop products faster to accomplish external participant´s expectations and the additional care needed to evaluate a product not originated under internal control.

With crowdsourcing, another key point must be raised. This is the rethinking and, maybe, redesign of what Khurana and Rosenthal [20] called "integration of activities": matching agendas, resource allocations, technical and organizational interfaces, etc.

An important tradeoff that companies considering crowdsourcing as an option might confront is the loss of learning and internal building of creative capabilities resulting from not participate of the positive effects [6] of FFE versus the avoidance of many negative effects of the phase [6].

About this aspect we infer that a challenge will be to *develop capabilities* to absorb efficiently the knowledge generated, not only in the FFE but in the whole crowdsourcing process, to benefit efficiently from its outcomes.

Another issue to be solved could be the one associated with the *risks of signaling* to the rivals in what the organization is working for. For instance, if an open competition for ideas to solve a problem is launched, at least some information will be hinted, and that could have implications for moving strategic advantages.

Understanding that the FFE phase presents different fuzziness levels, as showed in Figures 1 and 2, and based on many of the crowdsourcing characteristics studied, we concluded that crowdsourcing could reduce or increase the fuzziness of the FFE stage, depending on which specific source or dimension is considered.

Next, based on the literature reviewed, we developed the possible effects of crowdsourcing use in the FFE sources and dimensions studied by Chan et al. [6]. Table 5 presents these potential consequences.

Considering the FFE expected results postulated by Kim and Wilemon [21], we also present possible considerations resultant of the use of crowdsourcing in the FFE phase in the table 6.

Using the initiatives to manage FFE suggested also by Kim and Wilemon [21], we consider that the next adaptations need to be addressed if a firm aims at implementing crowdsourcing in its innovation process:

1. *Assign a FFE manager or designate a FFE team*: With crowdsourcing, the leader and team will also be needed but with a stronger evaluation role of the crowdsourcing process and its outcomes.
2. *Provide organizational support for FFE activities*: We consider that a significant reorganization should be made to reap the outputs of the process.
3. *Understand the nature and sources of ambiguity*: Probably lost, at least partially, because the solving process will not be carried on inside the organization integrally.
4. *Build an information system and efficient FFE processes*: More necessary than in a conventional FFE process. More akin to an open innovation model.
5. *Develop relationships with supporters, partners, and alliances*: Will change, compared to the closed model. However, different and valuable alliances with the brokerages organizations and/or the crowd can be developed.

TABLE 5. SOURCES, DIMENSIONS AND IMPACTS OF CROWDSOURCING USE IN THE FFE STAGE

Sources of Front-end Fuzziness according to Chang et al. [6]	**Potential impact of Crowdsourcing use**
Environment: - General environment - Task environment	 - Fuzziness reduced by the proximity to a diverse crowd - Fuzziness reduced by the proximity to potential customers and its needs / Fuzziness increased by the possible disclosure of information to competitors and strategic alliance established at crowd level.
Means: - Strategic level activities - Operative level activities	 - Fuzziness increased by the uncertainty about consequences to the firm - Fuzziness reduced by the massive generation and even evaluation of ideas / Fuzziness increased by multiplication of inputs
Goals: - Intermediate goals - Final goals	 - Fuzziness reduced by the improvements in productivity or innovativeness / Fuzziness increased by uncertainty in strategic fit or quality - Fuzziness reduced by better identification of opportunities and generation of product ideas/concepts
Dimensions of Front-end Fuzziness according to Chang et al. [6]	**Potential impact of Crowdsourcing use**
Uncertainty: - The lack of ability to process relevant information - The absence of information and Knowledge	 - Fuzziness increased by multiplication of information - Fuzziness reduced by the massive generation of information
Equivocality: - The ignorance of existence of causal relations - The diversity of interpretations	 - Uncertain impact - Fuzziness increased by the multiplicity of actors participating
Complexity: - The number of interactivities - The range of differences	 - Fuzziness increased by the multiplicity of actors participating - Fuzziness increased by the diversity of the crowd
Variability: - The intensity of change - The rate of change	 - Fuzziness reduced by the proximity to a diverse and wise crowd

TABLE 6. POTENTIAL IMPACTS OF CROWDSOURCING USE IN FFE RESULTS

FFE results according to Kim and Wilemon [21]	**Potential impact of Crowdsourcing use**
Identifying opportunities and preparing a clear product concept	• Massively potentiated by the identification and selection of opportunities initially expected and the appearance of unexpected new ones derived from the crowdsourcing process • Better concept definition derived from the participation of diverse and (in some cases) experienced crowd
Developing relationships internally and/or externally	• Might raise issues in the management of internal relationships while develop a new kind of external relationship with the crowd that, if well managed, might be sustainable in a long term and reinforce the brand
Speeding the process	• Great improvements in schedules (if an adequate evaluation can be implemented)

With this outlook, what firms could do to tap this new option?

A central and initial decision that the company should make is to implement the initiative through intermediaries (e.g. "solver brokerages" [14]) or to do it internally. From our review, the former seems to mitigate many of the problems with crowdsourcing presented in this research but the latter is a less expensive option.

Afuah & Tucci in [1] point out an interesting twist: "crowdsourcing can be internal to an organization", especially in the case of large firms that have many workers outside R&D. Vukovic and Bartolini [33] also mention this point, considering three forms the crowd could take: Internal (composed of employees), External and a Hybrid.

Finally, a valuable consideration brought by Djelassi and Decoopman in [9] is that probably it will be better to take a gradual approach to the introduction of crowdsourcing practices.

Like Kim and Wilemon [22, p. 37] say, we believe that the decision to interact with external entities should be based on the sources of fuzziness and how critical is its level for the management of FFE. As Marjanovic et al. [26] state, forms like crowdsourcing should not be viewed as substitutes, rather as complementaries in a process of innovation inside the firm.

In any case, we address the importance that crowdsourcing outcomes need to be aligned with the main strategy of the firm.

VI. REMAINING RESEARCH QUESTIONS

In this section we wanted to include a series of research questions that arouse from our study. In the end, we will also suggest alternatives for empirical research.

There is the question about the sectors/industries in which crowdsourcing is more likely to succeed? Are there significant differences among them? What about the differences between innovation types?

How to manage the scheduling conflicts between crowdsourcing and other participants' activities (leisure or even formal working time)? (e.g. Lay's contest finalists case in [9, p. 686]).

A question about Intellectual Property: What are the different activities in IP that should be fulfilled if crowdsourcing is implemented, compared to the conventional way? For instance, how to control that the ideas presented were not already extant and belong to a different owner, when thousands of proposals needed to be evaluated?

The people will always be willing to give up its ideas for free or almost for free? Or the tendency will be that progressively the scheme will take place only including the exchange of money? Or as some authors find, the non-monetary rewards will be more important in these models. Will it always be like that?

Maybe a tendency in the near future will be the emergence of a new kind of workers, people dedicated "professionally" and exclusively to these tasks?

Some other of our questions are related to Human Resources and Organizational issues.

What happens with the R&D team, which mostly works isolated from the rest of the organization, even in the traditional model, when it is pervaded by the work from an external crowd? What this implies to the "Not invented here" (NIH) syndrome? [24].

It should be expected that personnel, previously dedicated to develop functions in this area, feels "threatened" by the work and results from the crowd? What its implications for organizational behavior and climate?

In a similar line, Kim & Wilemon [22] state that "resistance to change" is expected to be present in the FFE phase of innovation, even in the traditional way. How this changes when crowdsourcing intervenes?

We also consider that not enough research was conducted about the consequences of the learning in the FFE when the firm opens to the crowd. Studies about the optimal organizational configuration that minimize the loss of learning in FFE and exploit new ways of learning surely will be appreciated.

In some of the literature reviewed, we notice that cultural differences should be regarded, but if so, cultural aspects as language make that crowdsourcing be not as global as stated? In the end the contributions are reduced to a related circle?

Other question has to be with the use of Internet as a possible factor that improves the probability of solutions, facilitating the participation of the solvers, not only technologically but also psychologically. If personal interactions were necessary to took place, the results would be the same?

Next we present some suggestions of specific empirical studies.

An interesting study could be one that compares organizations that managed the crowdsourcing process on its own with the organizations that only turn to intermediaries.

Another could be a survey about the profile of the participants in this type of activities, in a similar vein as Hars and Ou [15].

Studies about the screening and evaluation of ideas in immense quantities, as crowdsourcing produces, could be very useful also.

To measure the crowdsourcing contributions to the accuracy in the development of the products, could be interesting to study the variability between the definition of products with crowdsourcing when the FFE ended and the products actually produced.

Possibilities of action research, from the design to the final of the process, in an organization that decides to implement crowdsourcing in its FFE stage appear as another option.

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